ISSUE 500 ANNIVERSARY SPECIAL
WORLD'S LONGEST RUNNING PC MAG*

apc

SINCE 1980
DECEMBER 2021

41 YEARS IN PRINT

CELEBRATE WITH US

ISSUE# 500

THE INCREDIBLE MACHINE:
THE PAST, PRESENT & FUTURE OF THE PC

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History of the supercomputer

FROM WW2 TO CRAY, TO WHERE WE ARE TODAY

WHERE WE'RE HEADING

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EDITORIAL

A VERY SPECIAL ISSUE INDEED

AUSTRALIAN
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EDITORIAL

FIVE HUNDRED

From 1980 to today – and beyond.

BEN MANSILL
Ben's been editing tech mags since 1994, and has always regarded *APC* as the absolute pinnacle of tech publishing.

In June last year *APC* celebrated 40 years in print. Today, we're passing through the lovely big issue number 500. Our next major milestone will be our 50th birthday.

These are truly awesome and humbling achievements, and the credit for making it this far is spread far and wide, and well into the past. All of the current and former staff deserve a slice of this cake. To our current main squad: Joel, Troy, Shaun, Chris, Nick, David, Cam, Mark and Darren – thank you for your ongoing amazing work. Plus of course the behind the scenes team, without whom we'd be in a hopeless mess. A small army brings you *APC*, and they're all champions.

I had the enormous pleasure of speaking with many of the last couple of decade's *APC* writers and editors as we put together the 40th anniversary issue – and that included a very special page written by our first editor Sean Howard.

But for this extra special issue I turned to two people in particular to help tell the story of the PC and *APC* through the ages from a different angle. Jeremy White was *APC's* editor through most of the 1990s, which was a pivotal time for both the PC and this magazine. His words in this issue take us back to the emerging internet in a compelling and beautifully told story. And, telling the longer story of the complete history of the mag and the machine, long-timer Darren Yates – who began back in the Jeremy White era – weaves a tale of the decades-long evolution of the PC and how we covered it. Chris added a timeline of the PC's most impactful moments and it all serves to remind us that the machine sitting in front of us today really is something incredible.

> *Joel, Troy, Shaun, Chris, Nick, David, Cam, Mark and Darren – thank you for your ongoing amazing work. Plus of course the behind the scenes team, without whom we'd be in a hopeless mess. A small army brings you APC, and they're all champions.*

Many of our friends across the PC industry also sent their congratulations, and there's some big names here that shared their best wishes.

To bookend these stories, we have a terrific feature about the very first electronic computers, and another that looks ahead at the impending new technologies and products that will shape the PC for the next few years.

Every one of you though, our dear readers, ultimately makes our long life possible, and we truly do thank you for your ongoing support. To the readers of the past we are honoured to have played some part in quenching your thirst for PC knowledge. To those new to *APC*, we promise to give you the insight and understanding that made this magazine great. Onwards!

* *On the cover we couldn't quite fit in the words 'English language' in our claim of being the world's longest running PC mag. Such a pity. The ultimate honour belongs to German mag CHIP, which launched in 1978. For the English-speaking world, though, we're #1.*

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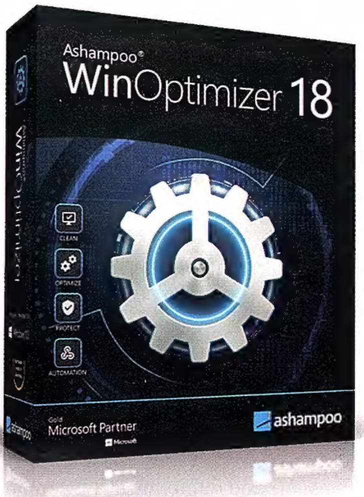
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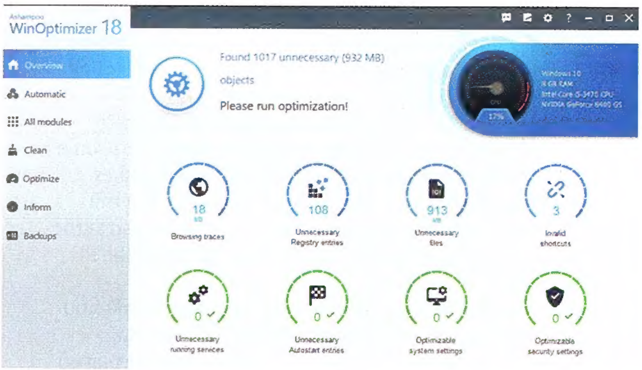
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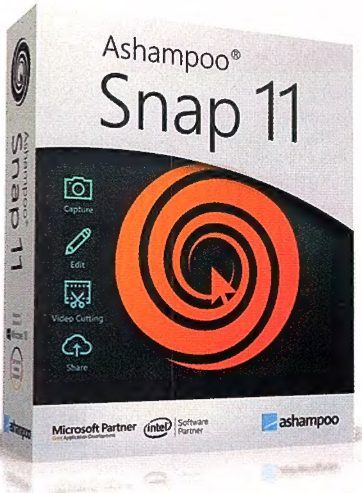
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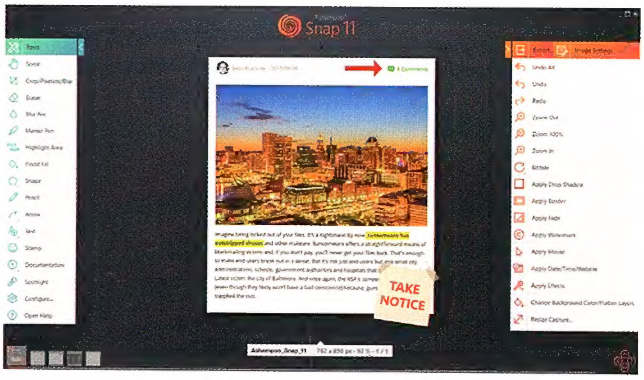
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The original 2-in-1 bends into a new clamshell shape and the transformation might just be good enough to start a new fad **051**

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An enterprise laptop that means business **052**

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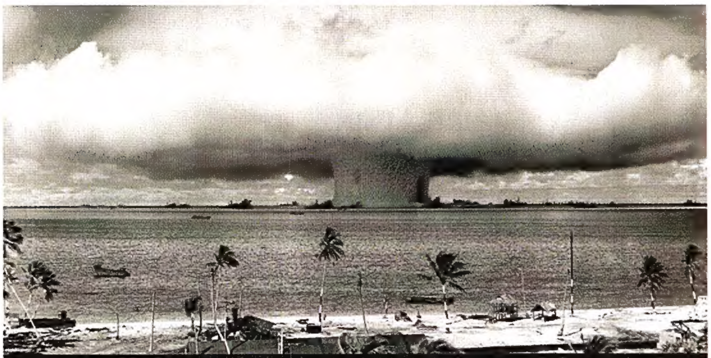
NEXT-GEN PC TECH REVEALED

PC tech standards are constantly changing. *APC* breaks down what to expect from the next generation of computer hardware **Page 056**



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Next-gen PC tech revealed

> “Championing technology doesn’t mean we’re unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage.”

HOW WE DO IT

Inside *APC*

Find out all about *APC*’s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia’s oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We’re also an open church in terms of platforms. We know most people aren’t wed to a single brand’s products and use a variety of devices. And, like you, *APC*’s journalists want to know what’s good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn’t mean we’re unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we’ve flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred. ■

APC TESTBED

The current *APC* testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	MSI GeForce RTX 3080 Gaming X Trio
Memory	2x8GB Team T-Force Xtreem ARGB DDR4-3600
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

APC AWARDS

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APC EDITOR’S CHOICE

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You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

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TECHNOTES

ALL THE NEED-TO-KNOW TECH NEWS

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INTEL CONFIRMS NO CRYPTO LIMITS ON NEW GPUS

Mining on its new Alchemist graphics cards gets the tick.

In a recent round table interview about its Arc Alchemist GPUs, Intel revealed that it won't be employing any hardware or software limiters or locks to dissuade cryptocurrency miners. This could be seen as something of a missed opportunity for Intel, as Nvidia's hash rate limiter has been welcomed by gamers, despite the numerous hacks to unlock it.

In Intel's defence, these new GPUs are purely focused on gaming, not on trying to dissuade certain parties. As Intel's Roger Chandler says, "we're not designing this product or building any features at this point that specifically target miners." So while there won't be anything there to dissuade miners, there's nothing that's particularly attractive to them either.

Linked in 领英

MICROSOFT SHUTS LINKEDIN IN CHINA

Localised version being shuttered after seven years.

Microsoft has revealed its plans to shutter its localised version of LinkedIn in China later this year, though the company isn't giving up entirely on helping Chinese professionals find jobs online.

First launched in February of 2014, Microsoft was well aware that it would have to adhere to the requirements of the Chinese government on internet platforms when operating a localised version of its social network for professionals in the country.

Faced with a significantly more challenging operating environment and greater compliance requirements in China, Microsoft has made the decision to sunset the current localised version of LinkedIn later this year, while announcing a much simpler jobs site is in development.

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THE CHIP CRISIS

TSMC warns chip shortage to last through 2022

The chip shortage will never go away, here's why.

The semiconductor shortage will definitely extend well into 2022 after the chip provider for some of the largest tech companies in the world said that production will struggle to meet the soaring demand for its products.

In an online conference in October, TSMC CEO Dr. C.C. Wei said that TSMC foundry production capacity was still insufficient to satisfy the demand for its chips, especially orders for components used for high-performance computing (HPC) systems and 5G devices using the company's 5nm process node.

If TSMC is stretched thin across its most important process nodes, then a far greater number of industries are going to be impacted by the constrained capacity than if Intel were facing the same production constraints which impacts the more "traditional" computing market more than anything else.

In fact, even Intel is starting to contract with TSMC to make various chips and is itself starting to make chips for other companies like Amazon and Qualcomm to try and meet the global demand for semiconductor components.

The only way the chip shortage will ever be addressed, though, will be to build more foundries to increase capacity, since demand for this most essential component of modern technology is only going to increase in the future as more of everyday life becomes digitised, from smartphones to smart cities.

Dr. Wei also said during the conference that the company expects to begin mass production on its 2nm process node in 2025, and the company broke ground earlier this year on a new foundry in Arizona based on its 5nm process, which is expected to be completed in 2024.

Demand is only increasing, and its growth is likely to be closer to exponential rather than linear. Adding to the number of fabrication plants isn't going to be enough to keep up when we need to be multiplying the number of plants.

On top of all that, you have a physical supply chain that can disrupt production capacity at any number of points along the way, something we're seeing even with the recent port crisis in the US. All the while, demand might slow or even flatten out a bit, for a while, but it will never suddenly start declining in a way that could allow production to catch up.

> *Demand is only increasing, and its growth is likely to be closer to exponential rather than linear. Adding to the number of fabrication plants isn't going to be enough to keep up when we need to be multiplying the number of plants.*

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Security experts aghast at the scale of Twitch hack

"This is as bad as it could possibly be".

Hackers have absolutely bulldozed Twitch, swiping the site's source code and revealing everything from how much the top streamers make (a lot) to the existence of a Steam-like game client Twitch has in development, codenamed Vapor.

Twitch is still trying to figure out what exactly happened, but while that internal investigation unfolds – and it could very well take a long while, given the scale of the hack – security experts are warning of potentially dire consequences for the livestreaming platform.

"Reading of a data breach that includes the entire source code, including unreleased software, SDKs, financial reports and internal red-teaming tools will send a shudder down [the spine of] any hardened infosec professional," ThreatModeler founder and CEO Archie Agarwal told the *Threatpost* blog. "This is as bad as it could possibly be."

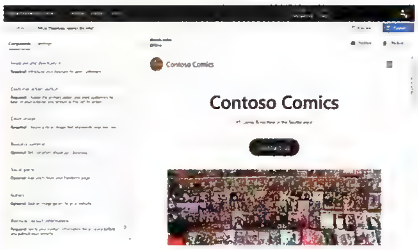
"The first question on everyone's mind has to be, 'How on Earth did someone exfiltrate 125GB of the most sensitive data imaginable without tripping a single alarm?' There's going to be some very hard questions asked internally."

Google is changing the way it handles 2FA

Google backup codes now have their own dedicated page.

Google is making it easier for users to sign into their accounts using backup codes after losing their smartphone with a new dedicated backup codes page. When users set up two-factor authentication (2FA) or two-step verification (2SV) as the search giant refers to it, the company issues 10 backup codes that can be used to gain access to your account should you happen to lose your smartphone or your security key. Since you no longer have a second device to verify that it really is you, you'll need to enter these backup codes along with your Google credentials.

In an update to the Google Workspace blog, the company announced that it has created a dedicated backup code page instead of a pop-up. However, you'll still access it from Google's 2-Step Verification list on Android, iOS and the web.



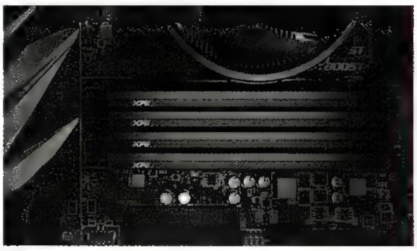
MICROSOFT IS SETTING ITS SIGHTS ON WEBSITE BUILDERS

Create an online presence for your business for free.

After introducing its free website builder back in February, Microsoft has announced a number of new features and integrations for Smart Pages which will make the service more accessible to small businesses looking to create their own online presence.

Previously users of the software giant's website builder were required to use the social and advertising tools in its Digital Marketing Center. Now though, Microsoft has announced a standalone mode for Smart Pages that allows anyone to create, edit and publish their own website without having to enter any payment information.

While not every business needs to advertise online, if a Smart Pages user does decide later that they want to do so, it's quick and simple to sign up for Microsoft Advertising to reach even more potential customers.



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ADATA OVERCLOCKS ITS DDR5 MODULE TO 8118 MT/S

Let the DDR5 overclocking contest begin.

DDR5 memory modules and supporting platforms are yet to hit the market, but DRAM houses have already started an informal DDR5 overclocking contest. Recently, Adata's XPG Overclocking Lab announced that it had managed to overclock the company's DDR5 memory module to 8,118 MT/s. This is the first time that a memory module house demonstrated overclocked DDR5 SDRAM sticks.

To hit a rather record data transfer rate, Adata's XPG Overclocking Lab took a pre-production 16GB DDR5 memory module based on ICs from SK Hynix with a stock data transfer rate of 4,800 MT/s and an unknown Intel Z690-based motherboard equipped with an undisclosed Intel's 12th Generation Core 'Alder Lake' processor. The system remained stable enough to load Windows and CPU-Z software.

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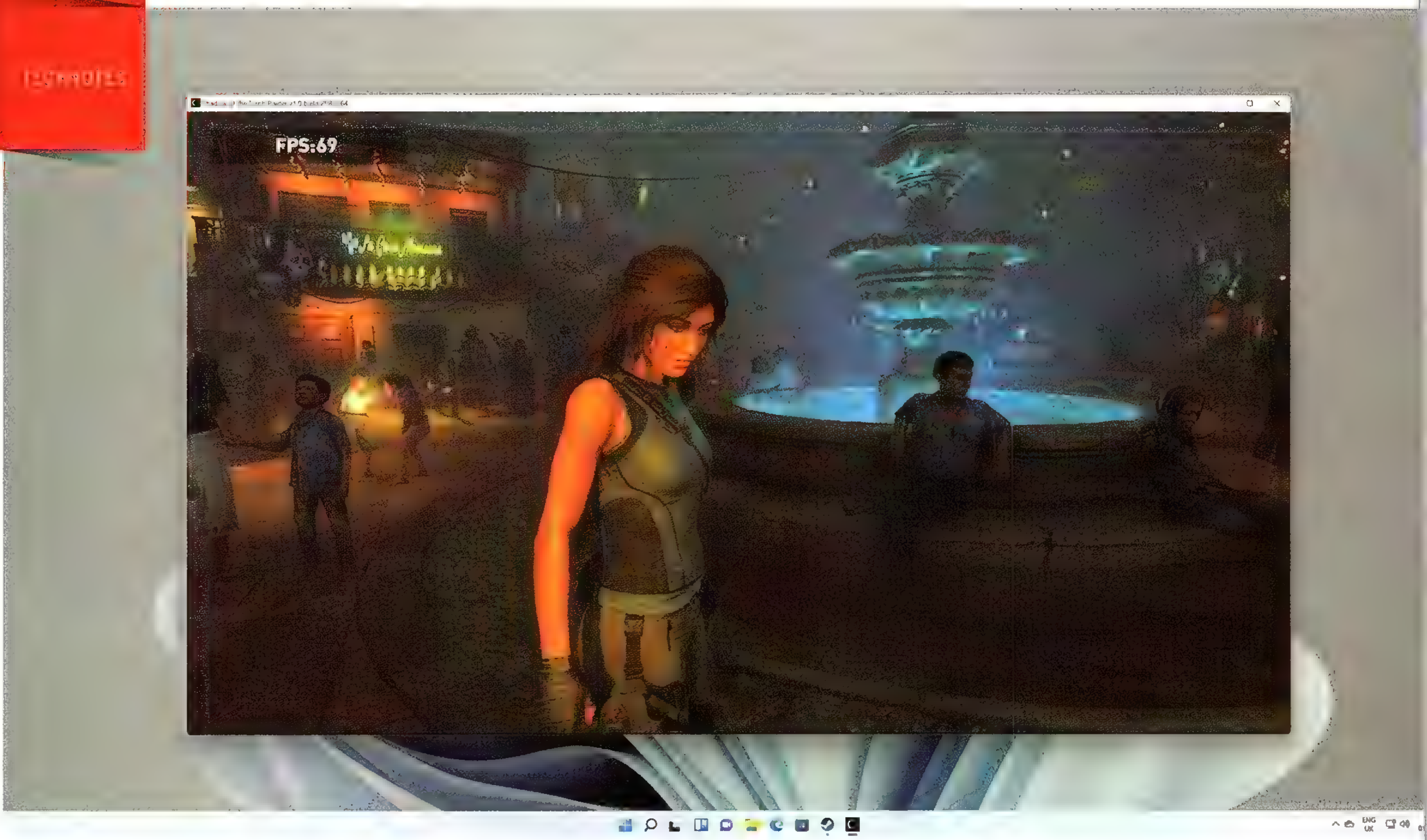

TECH BRIEF

Windows 11 could hobble game performance

Security feature can tank PC gaming performance by up to 25 percent on some PCs.

Despite Microsoft's claims that "if you're a gamer, Windows 11 was made for you" you will need to watch out for future prebuilt PCs with the new OS factory installed. That's because the Big M is enabling more security features in PCs by default, and one in particular can seriously tank gaming performance.

In our testing, that can add up to as much as a 28 percent drop in average frame rates. And you thought the TPM 2.0 restrictions were a pain...

That sort of frame rate delta is like dropping down an entire tier of graphics card and, in these days where GPUs are so hard to come by, Microsoft gimping the performance of the chip in your new machine would surely be hard for gamers to stomach.

The issue is Virtualization-Based Security (VBS), a setting introduced into Windows 10 that uses hardware and software virtualisation to enhance the security of your system. It basically creates an isolated subsystem that helps prevent malware from accessing your PC.

Microsoft explains it as follows: "VBS uses hardware virtualisation features to create and isolate a secure region of memory from the normal operating system. Windows can use this 'virtual secure mode' to host a number of security solutions, providing them with greatly increased protection from vulnerabilities in the operating system, and preventing the use of malicious exploits which attempt to defeat protections."

It's a feature mainly intended for enterprise customers to be able to lock down the corporate PCs they drop into their offices and make sure they don't get compromised. And if you're upgrading from Windows 10 to Windows 11 then you don't have to worry about VBS being enabled, unless you were already running an enterprise version of the older OS, that is.

Above: Windows 11 offers some truly wonderful benefits to gamers – we especially like Auto HDR.

But, if your Windows 11 PC has VBS enabled you will want to turn it off if your PC is mainly for gaming.

Windows 11
GAME PASS

The issue comes if you're receiving a machine which has had an OEM build of Windows 11 installed on it.

We've tested a selection of games on the current release build of Windows 11, with VBS off and VBS enabled (though not actually running) and the impact is obvious. *Far Cry New Dawn* is the outlier here, which barely shrugs at VBS, with just a five percent reduction in frame rate. But *Horizon Zero Dawn* drops by some 25 percent, *Metro Exodus* by 24 percent, and *Shadow of the Tomb Raider* by 28 percent. Interestingly, the 3DMark Time Spy score only dropped by 10 percent.

VBS is not enabled by default for all clean installs of Windows 11. But Windows 11 PCs built by the biggest OEMs, such as Dell, HP, and Lenovo are looking likely to come with VBS as standard. What we're not clear about, however, is whether those companies' gaming brands will also have VBS enabled. Or whether system builders will be exempt and can continue to ship gaming PCs without VBS.
DAVE JAMES ■

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END USER

Facebook is feeling the heat after years of scandal

The social media company needs to change, but it's making baby steps, writes Shaun Prescott.

Facebook whistleblower Frances Haugen testifies before the U.S. Senate.

Last month Facebook announced it would take steps to curb social media addiction, but the social media behemoth was typically light on details. It didn't make this announcement in a vacuum: It follows a series of investigative pieces by the *Wall Street Journal* in September which revealed, among other things, that the company has conducted its own investigation into how Instagram affects teenagers. The results of this research was far from flattering, with 32 percent of teenage girls reporting that the platform negatively affects their mental health.

That *WSJ* report was itself based on a trove of leaked documents from a former Facebook employee, later revealed to be Frances Haugen, who has also worked at Google and Pinterest. She told *60 Minutes* in the United States that of all three of those companies, Facebook was most egregious when it comes to putting profit before public safety. That's corroborated by the leaked documents, which also reveal that Facebook is all too aware of the polarising and radicalising effects of its platform.

But the effect on teen mental health is worth focusing on, coming from a company which, until it aborted the plan in September, had intended to release Instagram For Kids as a way to onboard young 'uns into the dystopian glories of social media addiction. In October, Facebook's vice president of global affairs, Nick Clegg (he of former British deputy prime minister fame), said that Instagram would introduce features that prompt young users to, in his words, "take a break" from the service, adding that Facebook would "redouble our efforts" to protect teenage mental health.

"We're going to introduce new controls for adults of teens, on an optional basis obviously, so that adults can supervise what their teens are doing online," he said during an interview with *CNN*.

"Secondly, we're going to introduce something which I think will make a considerable difference, which is where our systems see that a teenager is looking at the same content over and over again and it's content which may not be conducive to their wellbeing, we will nudge them to look at other content."

Haugen told the US Senate Commerce Committee in October that "the choices being made inside of Facebook are disastrous for our children, for our public safety, for our privacy and for our democracy," so those vague measures described by Clegg seem fairly negligible. This is from a company that self-promotes in a rather cultish way, as was also revealed by the leaks. Project Amplify was an internal initiative to disseminate positive Facebook stories into its users' newsfeeds. Indeed, if far-right groups and antivaxxers can propagandise on Facebook, why can't Facebook?

> *"We're going to introduce new controls for adults of teens, on an optional basis obviously, so that adults can supervise what their teens are doing online."*

SHAUN PRESCOTT
Author, *PC Gamer* editor and passionate technology observer, Shaun covers trending tech topics for *APC*.

Any time spent sifting through the leaks or reading secondhand reports paints a grim picture of a company well-aware of its dire societal impact but focused on the dollar nevertheless. As difficult, nay impossible, as it might be to enforce, it looks like the onus will be on parents to police social media usage among teens, though tough regulations are well-overdue – indeed, even Clegg admits to that.

It's fair to say that Facebook has had a rough few months, arguably rougher than Cambridge Analytica. These most recent leaks – and particularly the way they demonstrate a clear detrimental effect on people around us, or ourselves – are the culmination of a half-decade of ill winds for Facebook. In the 1990s, it seemed impossible that, for example, tobacco cartons would be emblazoned with gory images of their effect on your lungs. Facebook probably realises that, unless it moves quickly, its terrible blue website may be heading for similar treatment. ■

© Getty

The death of piracy and the life of print

Joel Burgess looks back at some of the critical stories from his 89 issues contributing to the *APC* legacy.

JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

One of my first articles for *APC* was back in issue 411, 'Has the Pirate Bay finally walked the Plank?', covered what appeared to be at the time the demise of a decade of internet and content culture where the high seas reigned supreme. At the end of 2014, Australia was still in the streaming dark ages, since Netflix wouldn't even launch till a few months later in March 2015 and Spotify was still working on quaint features like letting you see what your friends were listening to.

Sure, many had access to Foxtel, and if you were particularly posh you might've even had a Foxtel I.Q. box that allowed you to record shows and play them back whenever you wanted, but for most, the prohibitively high price of pay TV meant entertainment came from free-to-air or your local video store (yeah, we haven't seen one of those in a while, either).

It seems naive in hindsight to think that the raiding of Pirate Bay HQ in Stockholm, Sweden back in 2014 could have really cut the head off the online piracy snake, especially when you consider there's still Whack-A-Mole proxy Pirate Bay sites floating around the internet today. The site was only offline till February, an outcome that, perhaps, wasn't too hard to predict since two of the three Pirate Bay founders were already in maximum security prisons in Sweden following former raids.

The internet enlightened, at least, knew that you can't keep a thing like that offline for long – not when the big entertainment companies were working so hard to squeeze as much money as they could from paying customers. Watching movies or TV is a luxury that no one really needs, but this fact means that the companies selling it often get more free reign to act like monopolies and extort their customers. Instead of aiming to provide the best quality product to consumers and upscaling their output to build profit, entertainment companies were just bundling scraps with the occasional hit film or show and using those packages to bleed desperate customers for whatever they could afford, while keeping everyone else as hungry as possible.

The Pirate Bay

In this environment piracy was a giant threat to the whole monopolistic model that Hollywood was running on, and the clash of these two worlds culminated in the suits brought by Voltage Pictures in 2015 for people who torrented the Matthew McConaughey film *Dallas Buyers Club*. Voltage was really keen to test the limits of the legal system's willingness to uphold the values of pure free-market capitalism by suing individuals into the ground for not paying for the movie. Voltage threatened hundreds of thousands of dollars in legal fees if torrenters in the US didn't pay a $7,000 fine, and it won court proceedings in Australia to force ISPs to turn over the contact information of 4,726 local torrenters.

Fortunately, in August the Australian courts limited the amount of damages Voltage could demand from individuals in Australia to the cost of the films taken and reasonable expenses, which essentially made the company's legal action undesirable. At the same time, Netflix had successfully launched its Australian service in March 2015 and the launch of competitive local streaming services were on the horizon, poised to fundamentally change the global entertainment industry permanently.

The dramatic metamorphosis of the entertainment industry was undoubtedly the major story of my first year writing for *APC*, and while my stint at the magazine has only covered the last 89 of the magazine's 500 issues, *Australian Personal Computer* had been hitting the important tech beats at the same level for decades before I came aboard. It even managed to do all this through the changing media landscape of the last five years that many predicted would be "the death of print".

Not only did *APC* not die – it thrived. So here's to the next 500 issues of *APC*, which we suspect will detail how Facebook eroded the fabric of democracy and brought about the collapse of Western civilisation. Huzzah! ■

> *It seems naive in hindsight to think that the raiding of Pirate Bay HQ in Stockholm, Sweden back in 2014 could have really cut the head off the online piracy snake, especially when you consider there's still Whack-A-Mole proxy Pirate Bay sites floating around the internet today.*

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The things in Young Chris' life that made him the *APC* man he is today.

TWO BITS

500 issues of *APC*!

What a journey it's been.

I've been a tech geek ever since I can remember. As a kid, my first computing experience was gaming on a cassette-based Commodore 64 before eventually graduating to an Amiga 500. I had a friend with a 486 PC around 1994, and I remember arguing with him that the Amiga was the superior platform. In hindsight, he won the argument!

He had a pile of PC magazines with a whole bunch of programmes on disks that I wanted to use. Some of that stuff was really cool and I began to buy Amiga and PC magazines around then. Finally, I managed to convince my parents to buy a PC. For educational purposes of course! Microsoft Encarta on a CD, that was mind blowing. I recall the thrills of playing *Doom*, *Tie Fighter* with a joystick, even *Links 386* golf! In the 90s, mags like *APC* were chock full of information, tips and tricks that served me very well in those days. This was an era before the internet, and I'm positive that info from magazines including *APC* planted some of the seeds that led me to where I am today.

CHRIS SZEWCZYK
A life-long PC tech enthusiast, Chris has worked acoss the industry in many areas as a product and technology expert.

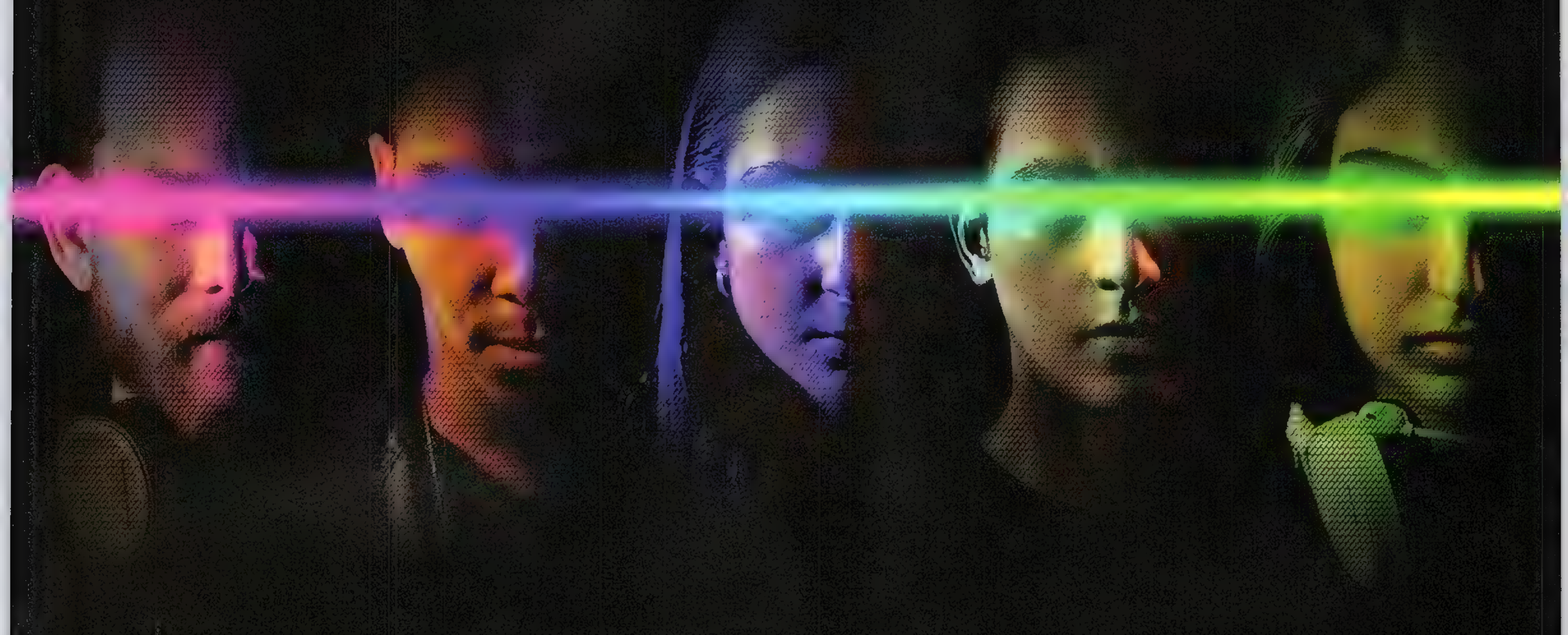
Many of our more mature readers likely have stories along the same lines from their younger days. Were you the go to person to fix a family members' PC? Did you think about a study or career path back then? You couldn't just Google those sorts of things in the 80s or 90s. Those folks that remember a time before the internet surely have knowledge that can be traced back to things learned in magazines all those years ago.

Moving onto the present, tech and tech media has evolved. Not unlike real books, there's still a place for printed content. There's no doubt that the rise of the internet and websites, Youtubers and influencers, has changed the PC journalism landscape. There's nothing wrong with that. It's good to get information from varied sources. But unlike a lot of amateur sources (not meant insultingly), *APC* and writers like myself are completely free to express our genuine opinions. We're professionals that are paid by our parent company. There's no 'cash-for-comment', clickbait nonsense, or brand favouritism in any of our coverage, so you can be assured that our content remains professional, unbiased, and relevant.

Looking ahead, Issue 501 will be a humdinger. Intel is about to launch its highly anticipated and vitally important 12th generation of processors. AMD has enjoyed most of the positive press over the last few years. Is the tide about to turn? We honestly don't know but we are definitely excited. In all of our 500 issues, you can probably count on two hands, if not one, the number of times the CPU crown has been passed from AMD to Intel and vice versa.

I'm proud and honoured to be a part of the journey. What will feature on the cover of *APC* issue 1,000? Quantum computing? Real time ray traced immersive worlds? Bio-computing? DNA storage? Perhaps none of our opinions will matter as *APC* will be written and produced by an AI in 30 nanoseconds instead of 30 days. The mind boggles.

Finally, a big thank you to you, our readers for supporting us in the past, now and into the future. The journey continues! ■



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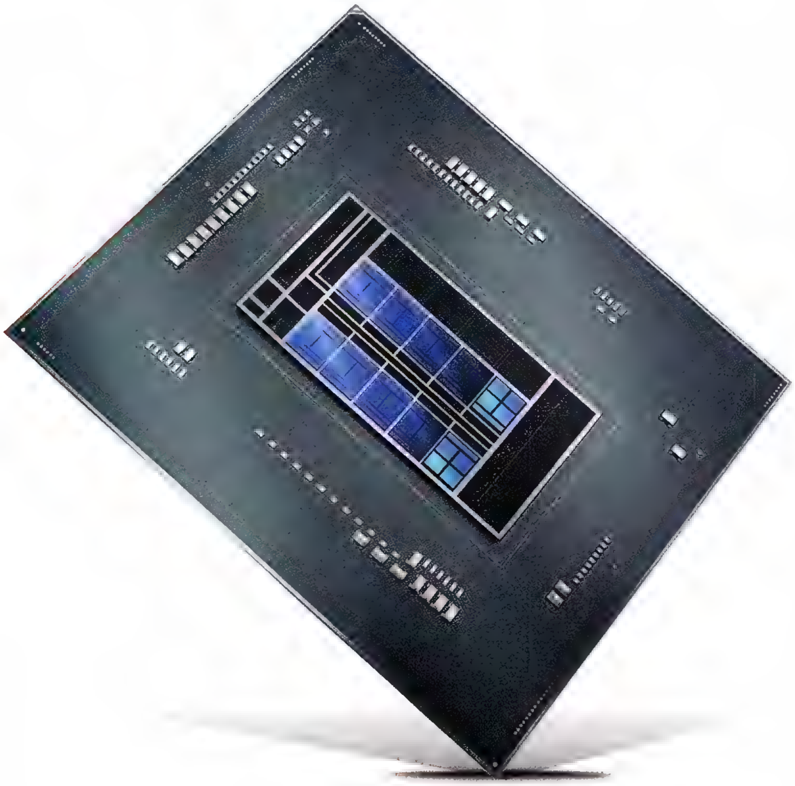

TECH TALK

PCIe Gen5 is coming

The specifications for PCI Express 5.0 are complete, and AMD and Intel will be supporting the tech, but initially only on data centre hardware.

JARRED WALTON
Jarred Walton has been a PC and gaming enthusiast for over 30 years.

Last issue I talked about the upcoming switch to DDR5 memory for the next generation Intel and AMD platforms. Now, I want to talk about something we won't see with AMD's socket AM5, and most likely not on Intel's LGA1700 Alder Lake CPUs either – at least, not on common consumer parts.

Before anyone gets too upset, let's talk about the reason behind the decision. PCIe signalling keeps getting faster, which requires tighter tolerances. Gen3 ran at a paltry 8 GT/s per lane (985MB/s to be precise), yielding a maximum throughput of about 16GB/s for an x16 slot. That's fast enough for a lot of use cases, including gigabit Ethernet and even 10Gbps USB 3.2. The ubiquitous PCIe Gen3 now handles audio, USB ports, networking, and all the x1 to x16 expansion slots. The requirements are low enough that it's possible to route all the motherboard traces to the further slots, and the power requirements are relatively tame.

Those last two items are the real problem with future PCIe standards. PCIe Gen4 effectively doubled the per-lane performance to 16 MT/s, and PCIe Gen5 doubles it again to 32 MT/s. Building the hardware that supports the standard is a different matter. Many laptops still omit Gen4 support entirely due to power requirements, and even those that do support the standard might only provide four lanes for the graphics chip (Tiger Lake-U), sticking with slower and less power-hungry Gen3 for storage and other devices. On the desktop, AMD's X570 chipset can support Gen4 on all PCIe links, but the B550 only supports Gen4 for the GPU and primary M.2 slot, and some boards don't even provide that level of support.

The issue with Gen4 is that it requires better signal quality, which means using better materials and/or thicker traces for the routing, more layers to the motherboard PCB, and potentially the use of retimers. That's why cheaper motherboards often skip Gen4, even if the chipset and CPU technically support it. And with Gen5, all those requirements become even more stringent.

AMD's socket AM5 won't have Gen5 support for the initial Zen 4 release, while AMD's Epyc Genoa server chips will support Gen5. Intel's Alder Lake plans are less clear. The CPU may support Gen5, but that appears to be mostly for servers and data centres. Sapphire Rapids (Xeons) and Alder Lake (12th Gen client) use the same core logic and support Gen4 and Gen3 as well as Gen5, but the costs and requirements of Gen5, plus validation, means we're unlikely to see support on client solutions in the next year.

It's probably for the best. We have only seen widespread Gen4 support on client products, such as graphics cards and SSDs, in the past year, and most PCs don't need even Gen4 speeds. We're a long way off from saturating Gen4 bandwidth for client workloads, but data centre and supercomputer needs are far ahead of home users. ■

> *Many laptops still omit Gen4 support entirely due to power requirements, and even those that do support the standard might only provide four lanes for the graphics chip (Tiger Lake-U), sticking with slower and less power-hungry Gen3 for storage and other devices.*

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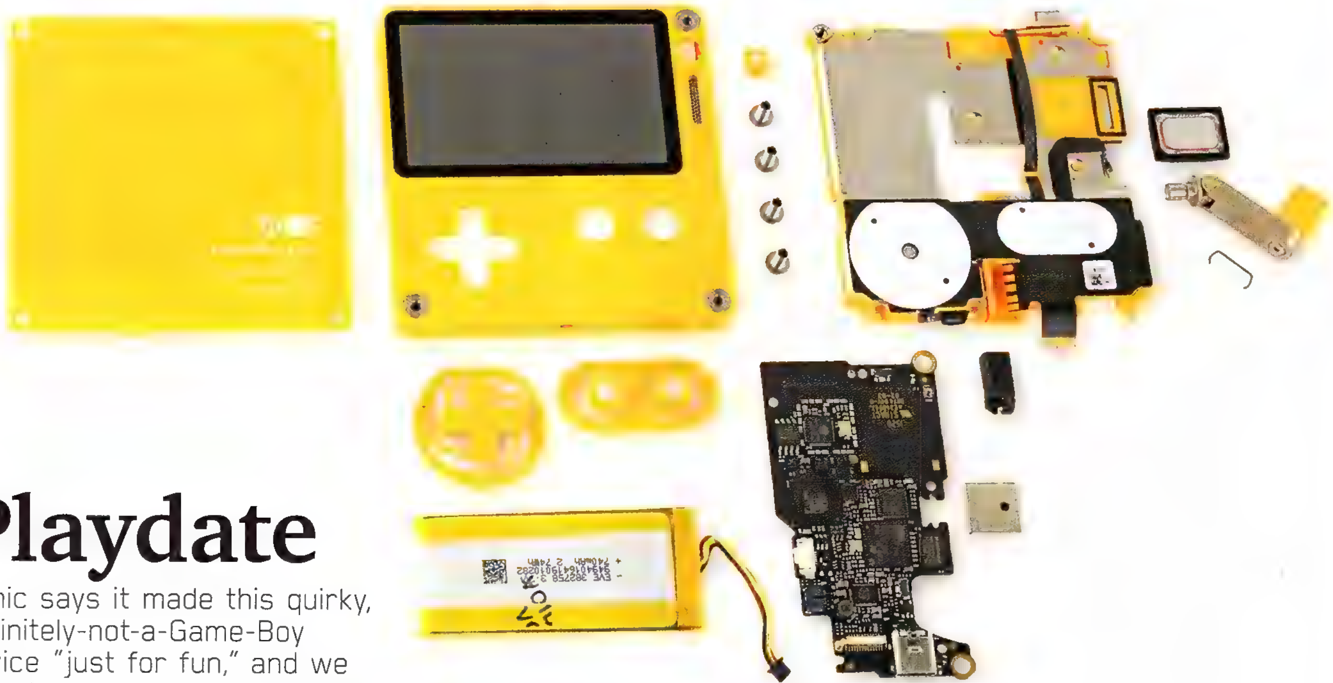
HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND



Playdate

Panic says it made this quirky, definitely-not-a-Game-Boy device "just for fun," and we sure had fun tearing it down.

Panic, the company behind this quirky not-a-Game-Boy, says it made this device "just for fun," and it shows. From the 1-bit screen to its distinctive crank, the Playdate radiates novelty. We just hope it's as much fun to tear down as it is to play on.

Full disclosure: Our unit came from Panic, who sent a Playdate for free. Unfortunately, it didn't come with any games, so a teardown was all it was good for. Little did they know, that's our favourite game (okay, they probably did know that).

Major tech specs

- Extremely high resolution (400×240) display; 2.7-inch at 173 ppi
- 180MHz ARM Cortex-M7F CPU
- 16MB of onboard memory
- 4GB flash storage
- 2.4GHz Wi-Fi (b/g/n), Bluetooth 4.2, USB-C, headphone jack
- Mechanical crank, because why not?

Key findings

We grab our big flathead driver for this diminutive console and twist away some screws. A few plastic clips stand guard, but a first look inside reveals an easily accessible battery. Hold on, there's a warranty sticker guarding it. We carry on, carefully.

Battery unpluggability: 8.5/10, mostly easy. Make sure you don't poke anything flammable with your tweezers. The battery is mildly glued down. It clocks in at 2.74 Wh (740 mAh @ 3.7V).

We separate pretty much everything from pretty much everything else. Both the display and crank stay ensconced in the forward housing, but everything else just flips out, provided you're deft with a spudger. We get an early look at how the crank works. No gears, just a simple Hall-effect sensor and a thing, enshrouded in white plastic. Is it important? We shall see!

But first, let's see what powers this pocketable piece of gaming goodness. The hidden side of the board contains seven key components, including 4GB of NAND flash memory and a whopping 128MB of low-power SRAM. On the other side, there are six more chips surrounding the CPU.

Time to pull the pin on this crank. There's a cylindrical magnet embedded in the shaft. As it cranks, the rotating magnetic field hits the Hall-effect sensor, which activates something in your game. One thing this crank won't do? Drift. There's no wiper, spring, or sensor surface to wear out. The design is simplicity itself. On the front, the tiny mono speaker is adhered in place.

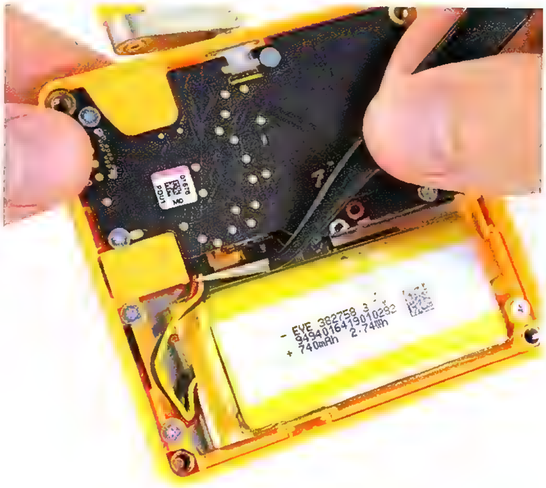
Here's where we come unstuck. The display is firmly glued to the enclosure, so to replace it, you'll probably need a new plastic face. Meanwhile, the buttons and other various I/O live on the flexible printed circuit, which is glued to the midframe. One bright spot, though, is the modular headphone jack.

Inside the cavity of the mechanical crank handle is some secret intel, model number PDU1-Y

Does it go back together and still work? Indeed it does. Our repairability scoring model isn't calibrated for the Playdate. It exists in a category all of its own, and we dug in mostly for fun. But getting inside and getting some parts out isn't too painful.

Repairability Score: 6 out of 10 (10 is easiest to repair). A big flathead screwdriver and an opening pick will get you inside. You can twirl away all the internal (Pozidriv) screws with a basic Phillips driver. The battery is accessible and only lightly adhered. The headphone jack is modular, and the crank design is simple and serviceable. You can swap the display, but only if you replace the front case. All of the controls are aggregated onto a single FPC – easy to swap, but wasteful if one thing breaks. The USB-C port is soldered to the mainboard. ■

Make sure you don't poke anything flammable with your tweezers. The battery itself is mildly glued down, so be persuasive but don't make it angry.



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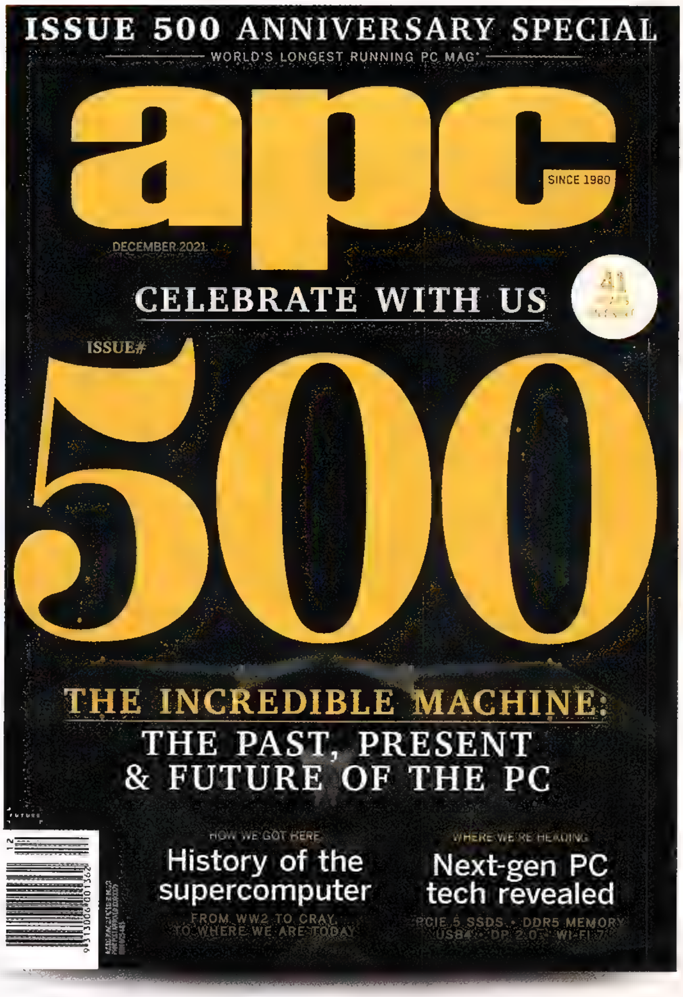
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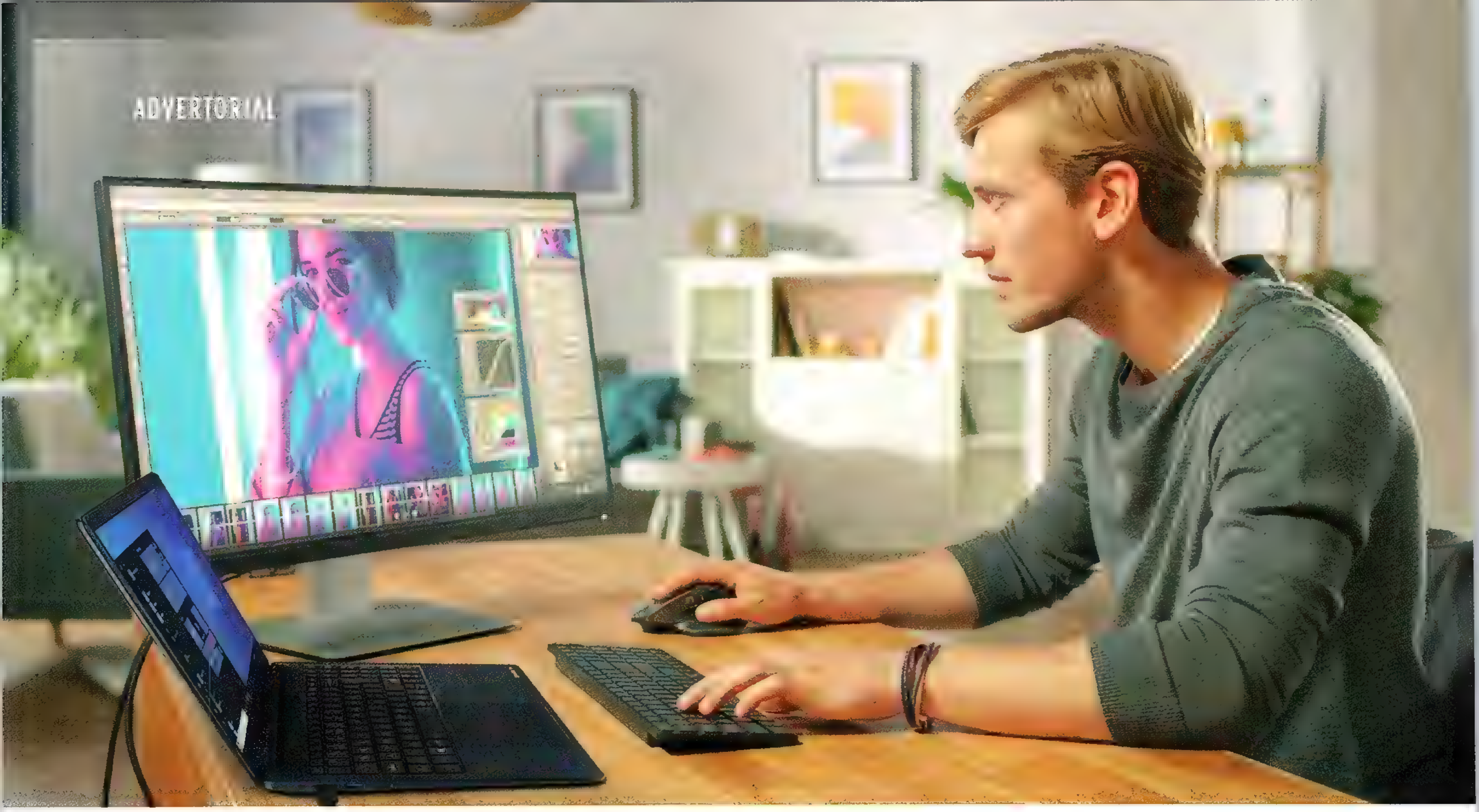
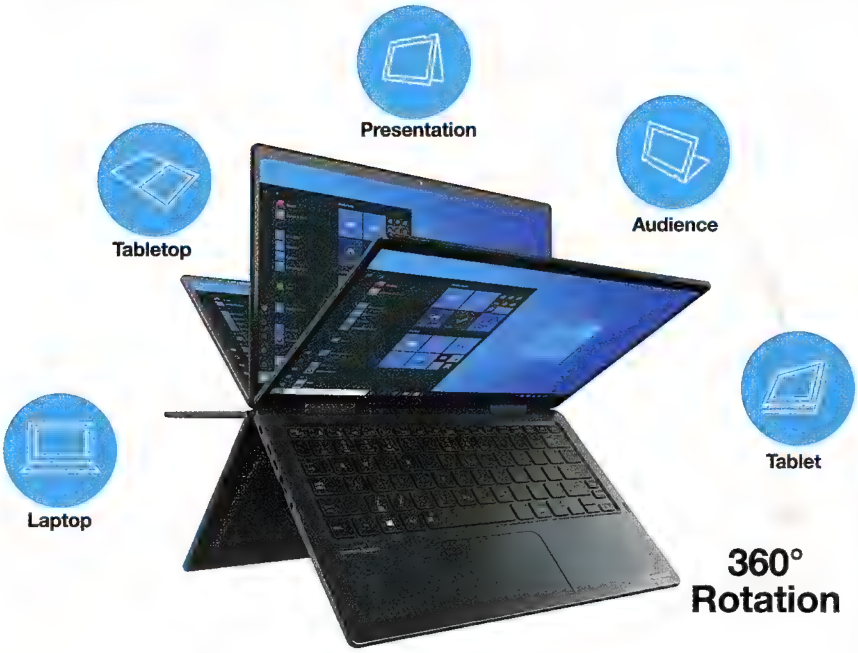


Dynabook in Australia

THE BUSINESS BRAND WITH A LEGACY OF MOBILE EXPERTISE.

Older *APC* readers will remember what early laptops looked like: bulky, heavy and downright-ugly plastic boxes that had appalling battery life. Using one represented necessity more than convenience and you'd be hard pressed to find anyone who was proud of their device. But, around this time, Toshiba's Portégé laptops appeared. If you saw them today, you'd be forgiven for mistaking them for modern ultraportables. At the time, they stood out in an office like a DeLorean in a car park.

Nowadays Toshiba's laptop division is known by its brand name, Dynabook. Over the years the Dynabook brand has become a major player across Asia, but it's relatively new in Australia. Now, the company is fully operational here and has service and support offices across the land.



Anyone that moves around or hits the road regularly will appreciate Dynabook's svelte Portégé X30W-J. Despite weighing less that 1kg, it still boasts an extraordinary battery life of up to 16 hours, and will wake from sleep in less than a second.

WHAT'S SO SPECIAL ABOUT DYNABOOK'S HISTORY?

Despite changing its name, Dynabook remains the same company that introduced the first laptop back in 1985 and pioneered over 30 major technological breakthroughs that are still used around the world. It was first used by tech visionary and Turing Award winner, Alan Curtis Kay, for his imagined portable computer concept that manifested as the Toshiba Dynabook T1000SE in 1989. It would subsequently become the flagship brand for Toshiba laptops in Japan.

The company pioneered the integration of long-lasting, compact batteries for laptops, pushed the boundaries of display capabilities, led the miniaturisation of components, developed materials for maximum portability and advanced breakthroughs in thermal management via patented air cooling and heat pipe configurations.

It's also set trends, not just in laptop design, but in the development of battery and wireless technologies, all of which have shaped the modern laptop as we know it.

Today, Dynabook continues to deliver the same, superior level of quality and reliability across a diverse portfolio of professional-grade, award-winning mobile computers that are ideal for the enterprise, SMB and education markets.

The Dynabook Satellite Pro C50 exemplifies the ideal modern business laptop. It's well-specced, solidly built and well-priced – and it doesn't hurt, either, that it's a sleek and classy looker.

WHAT SETS DYNABOOK APART?

A foundation of Dynabook's ability to maintain its industry-leading reputation for reliability is its extensive quality control which includes the multiple procedures used in its renowned Highly Accelerated Lifetime Test (HALT) methodology. These tests replicate a laptop's entire working life in a short period of time, meaning that all weak points are discovered and eliminated before going into production.

It means that not only are Dynabook's business laptops delivered ready to withstand the stresses and strains of everyday work life, but they also pass the strict conditions set by US military standard, MIL-STD 810G. This demands reliability in hostile environments, wide temperature ranges plus the ability to withstand vibration and drop tests.

There's also maximum security afforded through Dynabook BIOS. Indeed, Dynabook is the only supplier to develop, design and produce its own laptops entirely in-house, right down to BIOS – there are no third-party weak points. This helps explain why Dynabook has the industry's lowest failure rates.

Not surprisingly, many Dynabook customers are bulk-buying businesses seeking to outfit their workforce with computing tools that minimise downtime and stress. With that in mind it's worth noting that Dynabook sells exclusively through channel partners. That can mean working with a customer's existing preferred partner or assisting customers in finding one that best suits their needs.

WHAT ARE THE HIGHLIGHTS OF DYNABOOK'S CURRENT LAPTOP RANGE?

Satellite Pro – Exceptional performance. Powerful features

Dynabook's Satellite Pro range strikes the ideal balance between performance and portability for business. With a focus on mobility, extended battery life and powerful features, this laptop family is built for work and ready to handle any mobile computing task you can throw at it.

Portégé – Impeccable style. Unparalleled productivity

These first-class laptops deliver elite style and innovation plus the mobile performance and unlimited range you need – all in an ultrathin and ultralight package. They're 100 percent designed, engineered, manufactured and tested by Dynabook to maximise the quality and reliability that will set you apart from your competition.

Tecra – Performance and durability

Tecra empowers workers with the confidence to do more – whether on the move, or at their desk. It simultaneously delivers the robust performance of a fully-featured business-class laptop with the enhanced user experience afforded by an elegant, thin-and-light chassis. Whether you require a laptop that enables productivity, durability, reliability and/or advanced security, the Tecra range has you covered.

Also note that all Dynabook laptops have a wide range of matching accessories including bags, storage, docking solutions, mice, keyboards, batteries and chargers.

DYNABOOK IS YOUR PERFECT PORTABLE PARTNER

With an end-to-end design and manufacturing process, a 35-year legacy, a reputation for producing stunning-looking, reliable laptops, 170-million customers plus a channel partner and support network that spans the globe, Dynabook is your organisation's perfect partner for the purveyance of portable computers.

Check out Dynabook's newly re-invigorated website at **www.anz.dynabook.com**.

Every successful business places enormous importance on the reliability of its equipment, and Dynabook's Tecra A40 is built to go the distance without compromising the performance needed to get the job done.

GADGETS

NICE LITTLE THINGS.

$749 | vive.com/au

HTC Vive Flow

These futuristic goggles let you take the zen metaverse wherever you want.

The Vive Flow is a new portable VR headset designed to allow you to take your own virtual space with you wherever you go. The 189g device is great for connecting to your phone to watch videos in 3.2K resolution at a smooth 75Hz refresh rate, but if you're the millennial executive type then it's also great for guided meditation sessions in less than ideal environments. Vive Sync also lets you connect with friends or colleagues in a realistic digital space. The device has to be plugged into an external power source, but you can purchase compatible 10,000mAh battery packs to keep you in the metaverse longer.

$439.95 | au.kobobooks.com

KOBO SAGE

A elegant new flavour in the Kobo lineup.

The Kobo Sage is the more premium of two e-readers Rakuten released in October. While both the Sage and its more affordable $280 Libra 2 will get new Bluetooth functionality to allow you to listen to audiobooks, the Sage has a few additional perks to justify the premium price tag. The Sage will be the first mainstream e-reader to support a stylus input and the device is compatible with a PowerCover accessory that features an additional power bank. These are both optional extras, but you will get an 8-inch E Ink touchscreen with a 1920 x 1440 pixel resolution, 32GB of storage, IPX8 waterproofing and an adjustable backlight with warmth controls in a 240g package.

$1,299 | store.google.com/au

GOOGLE PIXEL 6 PRO

Google's new *Robocop*-looking flagship is here to relieve your smartphone troubles.

The Pixel 6 Pro utilises a new triple camera array to offer four times optical zoom through a telephoto lens, an ultra detailed 50MP main camera with a larger 1/1.31-inch image sensor and a 12MP ultrawide camera. The 6.7-inch QHD+ OLED screen has a variable refresh rate up to 120Hz that'll make gaming and videos silky smooth, and it's powered by a generous 5000mAh battery. The new custom Tensor processor and 12GB of RAM will keep everything lightning fast and Sub 6 & mmWave compatibility means the 5G connection is top notch. Not a bad spec sheet if you ask us.

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intel KiLLER E3100

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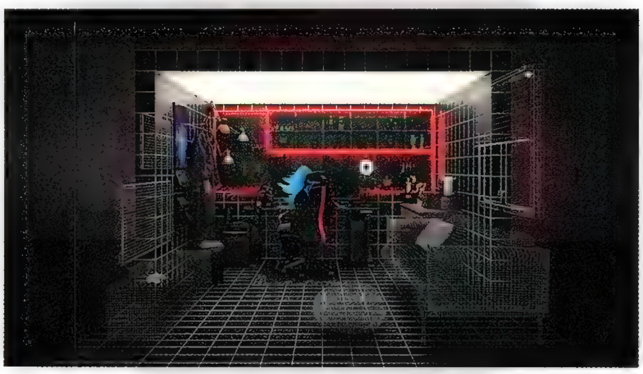
$179 | tado.com

Tado Smart AC Control V3+

Bring your AC into the digital age with a smart thermostat.

If you're still living in the smart home dark ages and you have to turn your AC on with a remote like a peasant, then it's about time you wised up to the tech that's out there. German AC specialist Tado is one of the leading smart home providers in Europe and it recently launched its cross platform smart AC Control V3+ device in Australia. Simply plug the V3+ in near your AC and connect it to your Wi-Fi and smart home system and you'll be able to use your phone or ask your smart assistant to adjust the temperature of your home or office.



Chair $249 | ikea.com/au

IKEA AND ROG GAMING SETUP

Look like a professional gamer without breaking the bank.

The new range from Ikea includes desks, chairs and a raft of office accessories to suit your gaming needs. Whether you're looking for a neon dark-mode desk setup with a PC tool pegboard and a $669 electronic height adjustable desk, or you want a sleek, all white, PC master race arrangement, this Ikea ROG collaboration has you covered. The Matchspel gaming chair comes in white or black colouring that you can add blue or red accents to depending on how loud you want it to be. There's even $15 PC stands with castor wheels so you can move your rig around with minimal effort.

$199 | logitechg.com

LOGITECH G435

Like it isn't even there.

Our happy little discovery of the month is these cans. Not because they're intended for gaming, but because we don't recall ever wearing headphones so light and comfortable, and thanks to that plus Bluetooth wireless they've turned out to be total winners for late night TV when you don't want to wake the rest of the house, plus the double bonus of no chance of tripping over a cord. They also support 2.4GHz wireless if you really want to game with them, which we wouldn't recommend because the sound is a bit thin. They're also carbon neutral and a quarter of the plastic is recycled. Logitech's sustainability is among the best in the industry, so well done them.

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MAY 1980

$2.20

ARTIFICIAL INTELLIGENCE WITHOUT TEARS
David Levy series on game theory

Left: The very first issue of *APC*. It all began in another century, in the same year that *The Empire Strikes Back* was released.

APC, THE PC, & YOU

There are 500 issues of *APC* today, and there will be many more to come. Join us as we take a moment to appreciate the PC, and the passion we share together for the magnificent machine.

Thank you. There are 500 issues of *APC* behind us, and it is you that got us this far. Whether you subscribe or just buy the occasional copy, you're the reason we do this, and can still do this.

We think we know you. You love the PC. It may have started as a hobby – a fascination – a thing that intrigued and demanded understanding. With discovery came a desire for more, and perhaps a career was born of this passion and desire. A lifetime of tinkering, tweaking, and fiddling followed. Along with the endless cycle of upgrading.

Many moments of joy came, as a new app or hardware upgrade made life better, or your gaming smoother and more beautiful. No doubt too, just as many moments of frustration and head-scratching as things did not work as they should. It's all part of it.

You are addicted to knowing what's just around the corner as PC tech marches ever forwards delivering more. You always want the best, the fastest, the most powerful – but that is tempered by the need to carefully budget your upgrades. There is so much joy in planning a new PC and indulging in the art of balancing the components – saving a little on something so you can go bigger on something else. Then, when the time comes, you hit the power button for the first time, or fire up a new app, or load up your most familiar game in its new faster home – and that's when the rush hits and the feeling is that wonderful pride and pleasure that is uniquely PC.

Ever since its dawn, circa 1980 – which is also when *APC* launched – through to today, the PC has changed lives, and the world. It is an enabler that has transformed business and pleasure. It has empowered individuals with exceedingly powerful ways to create, share, communicate, and have fun. It is the backbone of much of the workforce. It, in many ways, epitomises the technological revolution of the last few decades.

There are countless thousands of companies and individuals making things for the PC. Hardware, software, services. Each striving to lift it further, to make it do more, and do it better. We see this innovation every single month, year after year.

This is what drives *APC* forward, and keeps you coming back for more. The advancement of the PC is a blink-and-you-miss-it waterfall of endless technical evolution and innovation. If the PC is your passion you know that. You know you need to know more. We know it, because we do too, and it has always been nothing short of thrilling to continue following this marvellous journey with you.

Not many magazines make it this far. We're still here because we cover a topic that only ever gets more exciting, and does so at a rocket pace. You're still here because you seem to like the way we cover the PC, and its world.

Together we continue the journey. It is our honour to be part of it with you. Thank you.

THE PC ABIDES – & SO, TOO, DOES *APC* MAG

Former editor Dan Gardiner weighs in on his time at the mag and *APC*'s place in PC history.

As the magazine that gave me my first real job, *APC* maintains a pretty special place in my heart. I worked for the mag (on and off) for close to two decades, starting as a lowly product tester and reviewer and eventually working up to editing the magazine from 2013 to 2018 – what I'd consider a relatively 'stable' period in the history of the PC.

It was still, notably, one where desktop computing was under attack from multiple emerging technologies however – if you listened to certain analysts and marketing managers, smartphones, tablets and hybrid 2-in-1s were going to be the death of the traditional PC as we knew it.

I never believed a word of it, and while the ways in which we get our digital fix may have exponentially expanded in the last dozen years, the desktop and laptop haven't lost their place as the core, must-have computing devices if you want to get shit done.

The amazing durability of a mouse, keyboard, and monitor plugged into a sturdy beige/black/fluoro-RGB box cannot be understated. In fact, over the last 18 months, the global pandemic has proved that the PC isn't going anywhere, as the shift to working from home has resulted in widespread device shortages – it's 2021, and PCs are currently so popular that they literally can't make enough of them!

My aging-but-reliable desktop is still my favourite way of interacting with the digital world; with a couple of widescreen monitors, a mechanical keyboard and just a 6th-generation Core i5 and GTX 1080 (now both 6 years old!), there frankly isn't a lot it can't do... it's fast, efficient and it makes every other computing device in the house feel like a compromise.

I view *APC*'s enduring popularity as much like the PC itself – while we're certainly not afraid to change with the times, we've not forgotten the fundamental elements of what defines us, either.

APC knows what it is – a magazine for people who love PCs. While that's given us a pretty wide remit when it comes to what we can cover, the two core elements have always been clear: our readers want to know more about computers, and to discover cool things they can do with them. Those requirements mean that, like the PC arena, *APC*'s content has changed a lot over the years, but there's also been a surprising circularity to some elements. For its first few years, the mag routinely included pages of code for readers to manually type in so they could create and run new programs. While that need was replaced by cover disks, and then discs, and then downloads, with the rise of hobbyist computing devices like the Raspberry Pi we've actually seen the return of code to *APC* pages after decades-long absences.

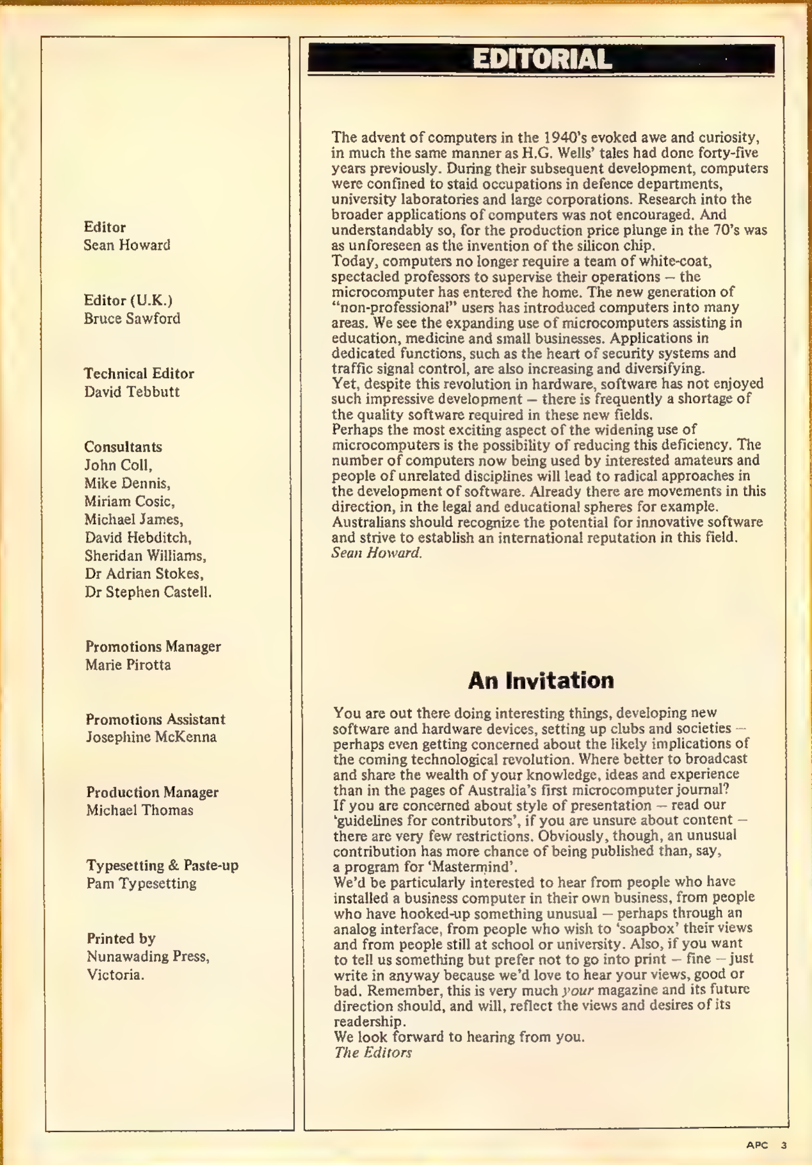
While the PC's ubiquity makes it an easy fact to forget, it is a device that has literally transformed our world – and *APC* has proudly been there since the very start of the revolution, objectively covering all the hottest products, flagging the important milestones and digging deeply into the topics that really matter.

For nerdy Aussie folk who love tech, I can't think of a better mag to have accompanied us on the journey. So here's to 500 – and to the many more issues to come!

Dan Gardiner
APC Editor, 2013-2018

THE WAY WE WERE

Issue #1 of *APC* in 1980 reflected the tech and publishing style of the day.



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EDITORIAL

The advent of computers in the 1940's evoked awe and curiosity, in much the same manner as H.G. Wells' tales had done forty-five years previously. During their subsequent development, computers were confined to staid occupations in defence departments, university laboratories and large corporations. Research into the broader applications of computers was not encouraged. And understandably so, for the production price plunge in the 70's was as unforeseen as the invention of the silicon chip.

Today, computers no longer require a team of white-coat, spectacled professors to supervise their operations – the microcomputer has entered the home. The new generation of "non-professional" users has introduced computers into many areas. We see the expanding use of microcomputers assisting in education, medicine and small businesses. Applications in dedicated functions, such as the heart of security systems and traffic signal control, are also increasing and diversifying.

Yet, despite this revolution in hardware, software has not enjoyed such impressive development – there is frequently a shortage of the quality software required in these new fields.

Perhaps the most exciting aspect of the widening use of microcomputers is the possibility of reducing this deficiency. The number of computers now being used by interested amateurs and people of unrelated disciplines will lead to radical approaches in the development of software. Already there are movements in this direction, in the legal and educational spheres for example. Australians should recognize the potential for innovative software and strive to establish an international reputation in this field.

Sean Howard.

An Invitation

You are out there doing interesting things, developing new software and hardware devices, setting up clubs and societies – perhaps even getting concerned about the likely implications of the coming technological revolution. Where better to broadcast and share the wealth of your knowledge, ideas and experience than in the pages of Australia's first microcomputer journal?

If you are concerned about style of presentation – read our 'guidelines for contributors', if you are unsure about content – there are very few restrictions. Obviously, though, an unusual contribution has more chance of being published than, say, a program for 'Mastermind'.

We'd be particularly interested to hear from people who have installed a business computer in their own business, from people who have hooked-up something unusual – perhaps through an analog interface, from people who wish to 'soapbox' their views and from people still at school or university. Also, if you want to tell us something but prefer not to go into print – fine – just write in anyway because we'd love to hear your views, good or bad. Remember, this is very much *your* magazine and its future direction should, and will, reflect the views and desires of its readership.

We look forward to hearing from you.

The Editors

APC 3

[illegible]

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NEWSPRINT

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BENCH TEST

Graphics

The Compucolor II disc drive and colour video.

Disc drives

Basic

File handling

Right: All the news fit to print from May 1980.
Far right: Our first computer review was of the Compucolor II.

Right: *APC*'s commander through the pivotal 1990s at his battlestation.
Bottom left: Jeremy and *APC* writer Angus Kidman party hard – a tradition that continues to this day.
Bottom middle: Some of the early *APC* team at at industry awards night.
Bottom right: Jeremy surrounded by the wonderful beige machines that hooked us all in.

APC, & THE RISE OF THE INTERNET

Jeremy 'Jed' White, our editor through the 1990s when the PC came of age, reflects on the monumental changes of the time.

I grew up reading *APC*. It was the 80s. Every afternoon after school, I'd walk past the newsagent at the train station, and peek in to look for a new issue. I was obsessed. The sweet days it appeared, I'd run home in a sweat to pore over the BASIC program listings printed in the back. Then play around for hours as the sprites and moon landers in the code danced on the screen. I'd read every article five times, and dream of writing them. I had a poster pinned to my wall, a map of Silicon Valley crowded with the names of now long-dead startups. I'd dream about starting the next Microsoft or Apple.

Nostalgia is powerful. There are periods that have an outsize impact on the world. The personal computing revolution led to the even bigger impact of the internet and mobile. In today's world, where tech is seen as the devil, and the media is full of divisive and sensationalist clickbait driven by the world's toxic ad-tech addiction, I think it's helpful to look back at the promise and hopeful energy of the 80s and 90s.

Internet Skunkworks

When I edited *APC* in the 90s, it was clear that the internet was going to change everything. A clear view doesn't equal a short distance. But this view was absolutely clear. Few media professionals believed it at the time, but we were lucky to have supportive and forward-thinking management at Australian Consolidated Press. We went all-in on the internet and editorial integrity, setting up a skunkworks-like operation within Consolidated Press, and moving to 100 percent Australian content with a religious mission to put readers ahead of advertisers.

The key to that was investing in Australian tech journalism, supported by large-scale local testing labs. Before then, most of the material in Australian magazines of all sorts came from overseas. We brought together a team of people that still leaves me in awe. Some were cadets new to the industry. Others were already stars and familiar faces to readers. They're all among the best tech writers Australia has produced, with countless awards between them. Their names fill this issue.

We shifted to a "tripartite" publishing model, combining print, web and interactive CDs. We built a suite of publishing software in-house. We launched daily tech news, new titles, and a popular start page and meta search. As the internet started to eat into newsstand sales industry-wide, *APC* tripled print circulation, and built one of the most popular online destinations in the world with a community of millions of readers. It led the rest of its parent company online. It was a golden age.

It was a dream to edit the magazine I grew up reading. I'd have done it for free. So many of *APC*'s writers were heroes, and our readers passionate supporters. But the magnetic force of that poster on my bedroom wall never

left, and programming and startups called. So in 1999 I left *APC*, and became a reader once more.

World-changing tech

Australia needs startups. We need people who risk failure to build new things. That's our path to becoming a global economic powerhouse that does more than dig stuff out of the ground and flog it overseas. Our country is slowly becoming less risk-averse culturally, and more supportive of startups. However, the personal cost of failing is too high, and it was higher then. Australia needs to do more to foster and encourage startups that can make a dent in the world's problems.

To Australia's great fortune, companies like Canva, Atlassian, and AfterPay have succeeded, and blazed a path that makes it easier for the next generation of Aussie startups to follow. It's a much more viable path now than it was back then thanks to them.

If you're thinking of building something, do it. Startups are the hardest thing you will ever do, with the highest highs and the lowest lows. When I first tried, it was tough, and I failed, made a million miserable mistakes, and failed again. I learned the hard way, but you don't have to. Startups are counter-intuitive. You can learn from successful accelerators like Y Combinator (behind Drobox, Coinbase, Airbnb and many others) in the US or programs like Startmate in Australia that make it a lot easier. Y Combinator's biggest lesson is simply to "make something people want".

There are deep-rooted problems in tech. Some are ripping society apart. The way to fix them is to build. I believe that deeply.

Into the future

As for me? I'm working on search. Search is broken. Google is so polluted with spam, content marketing and ads that it's often unusable. Ad-tech has flooded the web with obnoxious, privacy-invading ads that maximise clicks. We've become the product, not the customer. So I'm working on a new search engine that puts people first. It aims to deliver better results without ads, tracking or spam, and give you more control of searches. It's an early alpha version currently. It's name is ANDI, short for Artificial Neural Directed Intelligence, and you can try it out at **ANDISearch.com**.

We're at a similar inflection point now to when I was at *APC*. With the early days of Web3, crypto, and distributed ownership, you can feel that same sense of excitement and promise with new technologies that filled the 80s and 90s. Whatever that future looks like, it makes me deeply happy that *APC* is there to cover it. I'm excited to watch the next generation of Australian technologists and builders, and see what the world looks like after the next 500 issues.

Jed White
APC Editor, 1993-1999

The very first IBM Personal Computer (Model 5150) went onsale in August 1981 – just in time to get onboard the *APC* train to success.

THE STORY OF THE PC & *APC*

To celebrate issue 500, Darren Yates looks back at the history of the personal computer – and of the world's oldest continuously-published English-language computer magazine that predates it.

"Start publishing as quickly as you can before competition grabs the market". With this advice from UK publishing magnate Felix Dennis accompanying a box of magazines, a 21-year-old Sean Howard embarked on a new career path to launch Australia's first personal computer magazine. It was the era of the Sinclair ZX-80, the Tandy TRS-80 and in May 1980, the first issue of *Australian Personal Computer* rolled off the printing presses to explain this brave new world to technology enthusiasts.

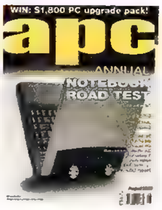
Despite the trials of the magazine-publishing game, *APC*, as we now know it, has survived and flourished, having been published each and every month since and this month tops a milestone 500th issue. Over the next few pages, we'll look back at the history of the PC, and the magazine that has tracked it ever since it all began.

Project 'Chess'

About the same time Howard was putting together the third issue of *Australian Personal Computer*, another fledgling effort was being organised, this time by tech giant IBM. Like many big companies of the time, IBM wasn't all that agile and an idea presented by Bill Lowe, director of IBM's Entry Level Systems unit, to produce a personal computer didn't overly excite the executives from the Corporate Management Committee. However, Lowe was less interested in creating new IBM technology and more interested in using what was already on the market.

IBM then-chairman Frank Cary was sold on Lowe's idea of a small team of engineers coming up with a product inside 12 months. The result was 'Project Chess'.

We take interoperability for granted today, but back in the 1970s and 80s, computers were siloed designs – each company created its own proprietary hardware and software combo to the point that as a consumer, you had to lock yourself into that company's vision of computing.



Rounding up the latest PCs and notebooks has always been an *APC* staple.

The goal for IBM was to use off-the-shelf parts wherever possible and create a computer system it could sell for US$1,500. The IBM Personal Computer 5150 arrived in August 1981, featuring a 4.77MHz CPU from Intel and an operating system from Microsoft. According to IBM, the only new designs it contributed were the system unit and keyboard. Nevertheless, the PC 5150 was an instant success, selling as many as 250,000 a month and the PC as we know it was born.

Kerry Packer's ACP

Meanwhile, the early days of *APC* were less-assured (Howard even

HISTORY OF THE *APC*-ERA PC TIMELINE *by Chris Szewczyk*

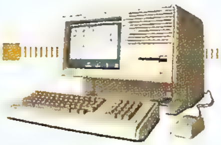
Personal Computer

APC ISSUE NUMBER ONE
MAY 1980

The very first issue of *APC* went on sale in May of 1980. 41 years and 500 issues later, we're still going strong!

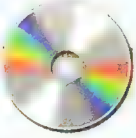
IBM PERSONAL COMPUTER
AUGUST 1981

The first IBM PC laid the foundations of today's PC ecosystem. Its open architecture and support for third party expansion cards, peripherals and software remain central tenets of today's PCs.



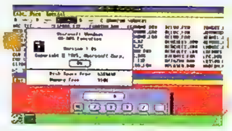
APPLE LISA
JANUARY 1983

The Apple Lisa was one of the first computers to feature a graphical user interface. Though considered a technically advanced machine, its very high asking price stopped it from gaining traction. It was quickly surpassed by the Macintosh.



CD-ROM
1985

The CD-ROM could hold up to 700MB, much more than hard drives at the time. Along with the audio CD, it heralded the beginnings of the digital age. The form factor persisted with the DVD and Blu-ray formats following in the decades to come.



MICROSOFT WINDOWS 1.0
NOVEMBER 1985

Though at the time it was a little rough around the edges, the user interface of Windows 1.0 led to a new era of user friendliness and it laid the foundations that led Microsoft to the dominant position it enjoys today.

resumed his studies at medical school for a time). But by 1984, the magazine had found its groove and a sister publication in *Australian Business Computer* appeared. That same year, it also caught the attention of Australian Consolidated Press (ACP) and its boss, Kerry Packer. The story goes that Packer asked for Howard's price to buy the magazines, which Howard duly offered. Packer's response is said to have been "Good God, son, compared to you, Ned Kelly was a princess!". Nevertheless, a deal with ACP was done that still kept Howard with part-ownership.

Computer Publications Pty Ltd now prospered with a growing stable of world-class titles that would include *PC User*, *PC Week* and, along the way, a little side business known as 'Oz-E-mail'. Howard eventually sold the remainder of Computer Publications to Packer in 1992, but Packer had no interest in the Oz-E-mail business and happily sold it back to Howard for $1 (Howard would eventually sell OzEmail for a reported $520 million).

Not long after the deal, Packer moved the magazines from their Bondi Junction digs to his 54 Park St headquarters in Sydney's CBD (often called the 'Tower of Power'). *APC* found its new home on Level 8 and got to work.

Intel Pentium

The intervening years saw the PC not only take off as a business machine as IBM hoped, but it was also handsomely winning the battle on the home front against the 1980s' home computers. The combination of 'IBM-compatible' and the non-proprietary nature of the hardware left the Commodore 64/128s, the Tandy TRS-80s and others to all but disappear from the market.

COMPAQ
Title

The 1986 Compaq DeskPro was the first IBM-compatible Intel 386 PC.
© MBlairMartin

IBM
Disk Key™

Above: Digital's HiNote Ultra was arguably the best laptop of the mid-1990s.
© PhotographyEdits
Above Right: The original IBM DiskOnKey had only 8MB of storage but revolutionised benchtesting.

A pivotal moment for the PC was Compaq introducing the first Intel 80386 IBM-compatible computer before IBM in 1986 – consumers for the first time began to realise that the tech on the inside mattered more than the brand on the outside. The floodgates were opening and IBM-compatible 'clones' flooded onto the market from new brands such as Dell and Gateway 2000, as well as more traditional names, including HP and Digital Equipment Corporation.

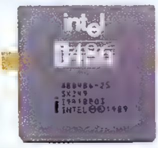
The 1990s began with rival chipmakers Intel and AMD kicking off their long-running legal war over the 80386 and 80486 CPU designs, yet it was the release of the Intel Pentium in 1993 that delivered the PC's next peak. The combination of Windows 3.1, released the previous year, and 80486-based systems enabled the 'graphical user interface' to begin changing perceptions of computers as devices to be programmed to tools to be used. Yet with its new superscalar design (the first form of parallel processing), the Pentium CPU delivered a significant overall performance jump, one that would come into its own in the latter half of 1995.

TOSHIBA T1100 LAPTOP
APRIL 1985

The Toshiba T1100 was the world's first mass produced PC compatible laptop. It was expensive and by current standards it was heavy at 4.1kg, but it was a genuinely portable PC. It was also among the first devices to ship with a 3.5-in floppy drive.

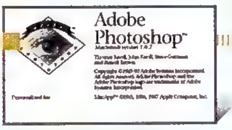
THE VGA GRAPHICS STANDARD
1987

The IBM VGA graphics controller and standard helped to define computer display technology, even up to the present day. 640x480 resolution with better colour support was a huge step up from earlier monochrome graphics.



INTEL I486 CPU
1989

The Intel 486 family of CPUs brought a massive performance jump, which in the early 90s really helped to propel the PC, and Intel itself, towards market dominance.



ADOBE PHOTOSHOP
FEBRUARY 1990

Though not without its critics, Photoshop remains the benchmark for photo editing software. Its influence even extends into popular culture. Almost everyone knows what it means to be 'photoshopped'.

SunDisk
SunDisk

FIRST MASS PRODUCED SSD
1991

Sandisk (then known as SunDisk) produced a prototype solid state drive that combined the low power and high speed advantages of RAM chips with HDD technology.

ACP Labs

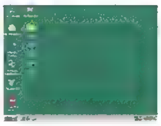
By 1994, the fledgling 'World Wide Web' accelerated interest in personal computers, along with new graphical user interfaces provided by Windows 3.1 and rivals like IBM's OS/2. It was at this point that Australian Consolidated Press put plans in place to create a purpose-built laboratory for testing the rapidly expanding cache of computers and peripherals hitting the local market.

Rumoured to have cost in excess of $1 million, 'ACP Labs' opened on Level 11 of 54 Park St with dedicated air-conditioning, raised anti-static floor and test equipment costing tens of thousands of dollars.

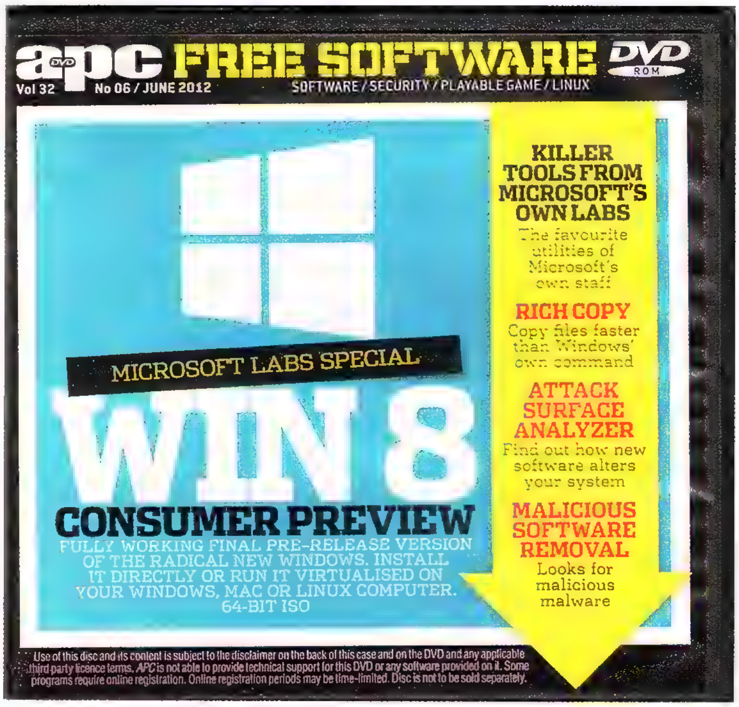
On a personal note, I joined Consolidated Press in June 1995 to work on *APC*'s new sister publication, *PC Magazine Australia*, and to enjoy what $1 million can buy you in lab equipment. I wrote my first *APC* article, a small book review, later in the year, but I'd also timed my arrival well – just two months before the launch of arguably the most influential tech product of that decade: Microsoft's Windows 95 operating system.

Start me up

Compared with today's world of highly secretive product releases, the launch of Windows 95 was anything but. Project 'Chicago' had been offered to users as 'previews' since the previous year. Moreover, users paid to join the preview program, while also providing feedback to Microsoft on features and bugs. It all meant that by the time 24 August 1995 rolled around, the Windows 95 launch event was the hottest ticket in town. It might seem as though Steve Jobs pioneered the modern 'tech launch' at Apple, but accompanied by the Rolling Stones' classic 'Start Me Up', Windows 95 brought with it plenty of Hollywood-grade hype. In reality, it was also the right product in the right place at the right time. The PC revolution was on.



Windows 98 brought with it USB, turning the PC into a gadget hub.



apc FREE SOFTWARE DVD ROM
Vol 32 No 06 / JUNE 2012
SOFTWARE / SECURITY / PLAYABLE GAME / LINUX

MICROSOFT LABS SPECIAL
WIN 8
CONSUMER PREVIEW
FULLY WORKING FINAL PRE-RELEASE VERSION OF THE RADICAL NEW WINDOWS. INSTALL IT DIRECTLY OR RUN IT VIRTUALISED ON YOUR WINDOWS, MAC OR LINUX COMPUTER. 64-BIT ISO

KILLER TOOLS FROM MICROSOFT'S OWN LABS
The favourite utilities of Microsoft's own staff

RICH COPY
Copy files faster than Windows' own command

ATTACK SURFACE ANALYZER
Find out how new software alters your system

MALICIOUS SOFTWARE REMOVAL
Looks for malicious malware

Use of this disc and its content is subject to the disclaimer on the back of this case and on the DVD and any applicable third party licence terms. *APC* is not able to provide technical support for this DVD or any software provided on it. Some programs require online registration. Online registration periods may be time-limited. Disc is not to be sold separately.

APC launched the first monthly cover DVD on an Australian magazine in 2004.

Benchmark testing

APC, too, was now right in its element and the shiny new 'ACP Labs' gave the magazine unmatched capability in PC testing, sufficient to test 100 PCs for its PC road-test issue in 1995. The lab was equipped with an Audio Precision System Two audio test measurement unit for testing sound cards, and we even had an expensive modem test unit for testing new 56K modems.

However, it was the science of PC benchmarking that accelerated during that Windows 95 era, with US publishing giant Ziff-Davis creating the Winstone and Winbench benchmarking CDs, considered 'gold' by all of us in the lab at the time (I still have mine). These benchmarks included locked versions of big-name apps such as Adobe Photoshop and Microsoft Office for repeatable testing of real-world PC performance. Ziff-Davis Benchmark Operations (ZDBop) stopped producing benchmarks around 2004, but this rigorous testing framework has been handed down and continues at *APC* today.

Y2K, 1GHz and XP

The ten years from 1995 to 2005 were halcyon days for the PC. The Windows 95 surge meant there were new PCs coming in every week, but so many of the awesome peripherals that changed not just *how* we computed, but *why* also came along during that time. CD burners, USB flash drives, MP3 players, DVD burners, digital cameras, video cameras, the list goes on.

But while Windows 95 gave us a glimpse of the computing future, it lacked the key ingredient that all of

HISTORY OF THE *APC*-ERA PC TIMELINE *Continued…*

FIRST LINUX RELEASE
SEPTEMBER 1991

The archetype of open source software. Despite never making inroads into the desktop market, Linux is the most widely installed operating system family. It dominates the server and supercomputer space, and it forms the basis of the Android operating system.

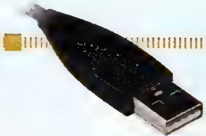
DOOM
DECEMBER 1993

One of the most influential games of all time. *Doom* was a pioneer in the fields of 3D graphics, networked multiplayer, and even modding. It helped to define the first-person shooter genre.

Microsoft Internet Explorer

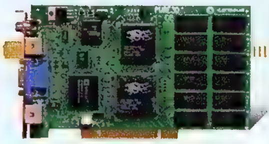
INTERNET EXPLORER 1.0
AUGUST 1995

In 1995, Netscape Navigator was the dominant Internet Browser. That began to change in August 1995 when Microsoft shipped Internet Explorer with Windows 95. IE quickly gained market share and it remained largely unchallenged for more than a decade.



USB 1.0
1996

USB was introduced to standardise the way peripherals were connected to computers. Its backwards compatibility, power delivery, support for hot swapping and ability to self-configure has led to its near universal support.



3DFX VOODOO GRAPHICS
1996

The Voodoo Graphics PCI card from start-up 3dfx was a 3D accelerator that transformed PC gaming. Does anyone remember playing *Quake* back in 1996? Perhaps the PC Master Race meme can be traced to this moment in PC history.

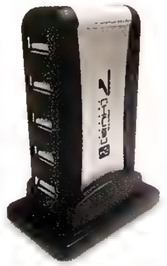
these peripherals would cry out for – USB. The arrival of Windows 98, and in particularly Windows 98 Second Edition (98SE), began turning the PC from a standalone device into a docking station for that growing array of gadgets we could no longer do without in our lives.

However, for the first time since its arrival nearly 20 years earlier, the PC was facing serious competition in the form of a rejuvenated Apple. With a $150 million injection from Microsoft that helped keep the lights on the year before, Apple launched the original iMac in late-1998 and all of a sudden, beige really did look… beige. Still, some PC makers attempted to liven things up with coloured options, not to mention some weird shapes (anyone remember the 'Fish PC'?).

But as the century drew to a close, the world was increasingly worried about a potentially far greater problem – the dreaded 'Y2K' bug. The need to save a few bytes of memory in the early years of computing resulted in the four-digit year being truncated to just two and the thought of 1999 rolling around to 2000 sent the world into panic. However, civilisation survived, life continued and the trains still didn't run on time.

After the kerfuffle, regular programming resumed and computers continued to speed up at an astonishing rate. CPUs back then were only single-core, but the key speed lever AMD and Intel chip designers could crank seemingly at will was clock-speed. In 1995, the fastest PC I tested was a 133MHz Intel Pentium that would've set you back up to $8,000 at the time. The next few years for me were a blur as CPUs arrived in labs from both vendors at regular intervals, each nudging the clock speed bar just ahead of the other. It was clearly becoming a race to see who would reach the coveted 1GHz mark first. AMD's Athlon processor got the chocolates in early-2000, just ahead of Intel's Pentium III by a matter of days. Not that it mattered much – by 2004, they'd both sailed past 3GHz.

The IBM Personal Computer 5150 – it's been around almost as long as we have.
© Rama & Musee Bolo



Above: Intel's Pentium processor came to life with the arrival of Windows 95. **Above middle:** The Tandy TRS-80 Model I was the popular home computer when APC launched.
© Rama & Musee Bolo
Above right: The Universal Serial Bus turned the PC into 'gadget central' in most homes.

The year 2000 heralded in arguably the first notable misstep from Microsoft with the release of Windows ME. The up-coming Windows XP operating system was to be a major departure from the Windows 9x platform, but it was still on the runway, leaving Microsoft thinking it needed a stop-gap measure. The result was Windows Millennium Edition, but still powered by Windows 95 technology, ME wasn't as stable as 98SE, didn't offer much that was new and looked rushed.

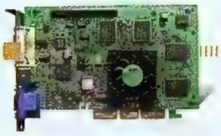
Thankfully, the same couldn't be said for its follow-up. Windows XP arrived in 2001 and was the first consumer OS built on Microsoft's Windows NT technology. It brought 32-bit architecture to home users and arrived at the right time to pick up on the multimedia revolution, as the PC became the home storage dock for media players, cameras and a booming range of USB gadgets. USB flash drives were revolutionary and for those of us in labs, greatly simplified the PC benchmarking process, particularly for updating video card drivers and, eventually, installing the benchmarks themselves. 2001 also saw *APC* and

LCD MONITORS TAKE TO THE STAGE
1997

1997 saw the first LCD monitors that could compete with the quality of CRT monitors. That and the fact that they took up far less space and used less power compared to CRTs led to their eventual dominance.

MICROSOFT INTELLIMOUSE EXPLORER
1999

The IntelliMouse Explorer was the first widely available mouse with an optical sensor. It was more accurate and worked on a wide variety of surfaces. The need to clean mice with rollers and balls was no more.



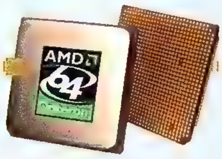
NVIDIA GEFORCE 256
1999

Considered to be the world's first 'true' GPU, the GeForce 256 was designed to handle processing previously assigned to the CPU. This led to less reliance on the CPU, though it did require game optimisation to take full advantage.

napster

NAPSTER
1999

Napster was a pioneering peer-to-peer file sharing application primarily aimed at MP3 sharing. Napster and the music industry clashed heads over copyright issues and it was an important brick in the road towards the modern streaming and sharing services we see today.



FIRST X64 CPU
APRIL 2003

AMD's x64 CPUs not only allowed systems to access far more memory, but they were back compatible and faster with x86 apps too. This period can be considered the golden age of AMD, until the release of Intel's Core 2 series in 2006.

the rest of the 'ACPTech' titles leave Park St and move around the corner into 181 Castlereagh St (since torn down to make way for Pitt St Station). For the first time in nearly a decade, *APC*'s lab and editorial were on the same floor!

PCs get properly 'mobile'

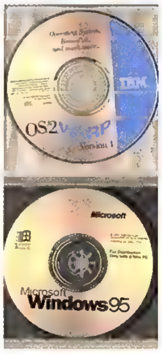
On the whole, the 1990s and early-2000s belonged to the desktop PC. With fewer electrical power constraints to worry about, desktops generally packed in whatever they could. By today's standards, however, laptops for much of that era were 'mini-desktops'. They tended to be powered by low-power desktop-class CPUs, used Nickel-Metal-Hydride (NiMH) batteries and had a battery life of around two hours. There were exceptions to that rule – Digital Equipment Corporation's HiNote Ultra series of thin, lightweight laptops in the mid-1990s were so good, Compaq resurrected it as the Armada 6500 and M300 series after buying Digital in 1998.

It wasn't until the combination of Lithium-ion batteries and the new Intel Pentium-M mobile processors of 2003-2004 that laptops finally came of age, with a much better combination of processor speed and impressive battery life topping four hours.

The mid-to-late-1990s was also the period Australian PC magazines perfected the cover CD. At a time when internet was still dial-up and you measured your download in kilobits, not megabits, the cover CD gave you 600MB of games, multimedia and utilities. *APC* was the first Australian magazine to make this a DVD with over 4GB of software in 2004. To get DVD manufacturing down to a cost-effective level and speed to deliver upwards of 100,000 discs per month was no mean feat at the time, and it remained one of the most popular features of the magazine.

Barred Windows

Still, by the mid-2000s, the prevailing sense was the PC was losing its lustre – processor performance had stagnated as clock speeds hit the 3.6GHz brick-wall. Windows XP had been the success the market needed after the lacklustre Windows Me, but XP was now five years old in 2006 and Microsoft faced a resurgent Apple soon to release the iPhone. It was into this less-than-favourable environment that Windows Vista dropped, promoting a renewed focus on security and a new idea: user account control (UAC). Despite its promise, UAC proved incredibly unpopular, providing Apple with a marketing 'free-kick' and one of the more memorable 'I'm a Mac; and I'm a PC' series of ads called 'Cancel or Allow?' (find it on YouTube). Nevertheless, Vista is still claimed to have managed an estimated 330 million users by the end of the decade.



Somehow, I just couldn't part with my OS/2 Warp and Windows 95 CDs.

Vista also arrived alongside Intel's Core 2 CPU series, which launched the multi-core CPU revolution that's still with us today (yes, the dual-core Pentium-D arrived the year before, but I always felt as a CPU, it made a better coffee-warmer).

The end of 2006 saw *APC*, along with the other 'ACP Tech' titles, on the move again, this time, leaving Castlereagh St for the altitude of Level 23 in one of Goulburn St's flashiest buildings, with bigger windows, a better view and a still-huge dedicated lab area. More broadly, *APC*, along with the rest of Consolidated Press and the Nine television network, were sold as a 50 percent stake to private equity firm, CVC Asia Pacific, at the end of the year.

Market changes

While Windows Vista arguably did more to raise the profile of Linux than almost anything else, Microsoft went a long way to righting the ship again with the release of Windows 7 in 2009. Vista quickly vanished from view, but the same couldn't be said for Windows XP. The arrival of the tiny Intel Atom CPU encouraged brands such as HP and Asus to create the 'netbook', low-cost ultra-compact laptops selling for less than $500. Initially, most sold with a Linux operating system, however, Microsoft quickly resurrected Windows XP for netbook makers.

Nevertheless, Windows 7 coincided with the early mainstream take-up of solid-state drives, which did as much to speed up perceived PC performance as anything else in the last ten years.

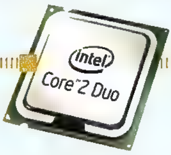
However, the PC's greatest threat arrived in the latter half of the 2000s, with the introduction of the smartphone and tablet. Within a few short years, the personal computer no longer sat on your desk or your lap, but in your pocket. Smartphones today still can't match the PC for speed, but

We weren't to lose our Winstone benchmark CDs. I still have mine 25 years later!

Ziff-Davis PC Benchmarks CD-ROM
Winstone® 96
WinBench® 96
New versions also include CPUmark32™, CD-ROM, and full-motion video tests!
WinBench® 98
Ziff-Davis PC Benchmarks
Business Winstone™ 2001
Content Creation Winstone™ 2001
Not for resale.

HISTORY OF THE *APC*-ERA PC TIMELINE *Continued...*

FACEBOOK
JANUARY 2004
What began as 'TheFacebook' in Mark Zuckerberg et al's Harvard University days quickly morphed into the behemoth we know today. Facebook now influences politics, economies, and culture in ways that were unimaginable back in early 2004.

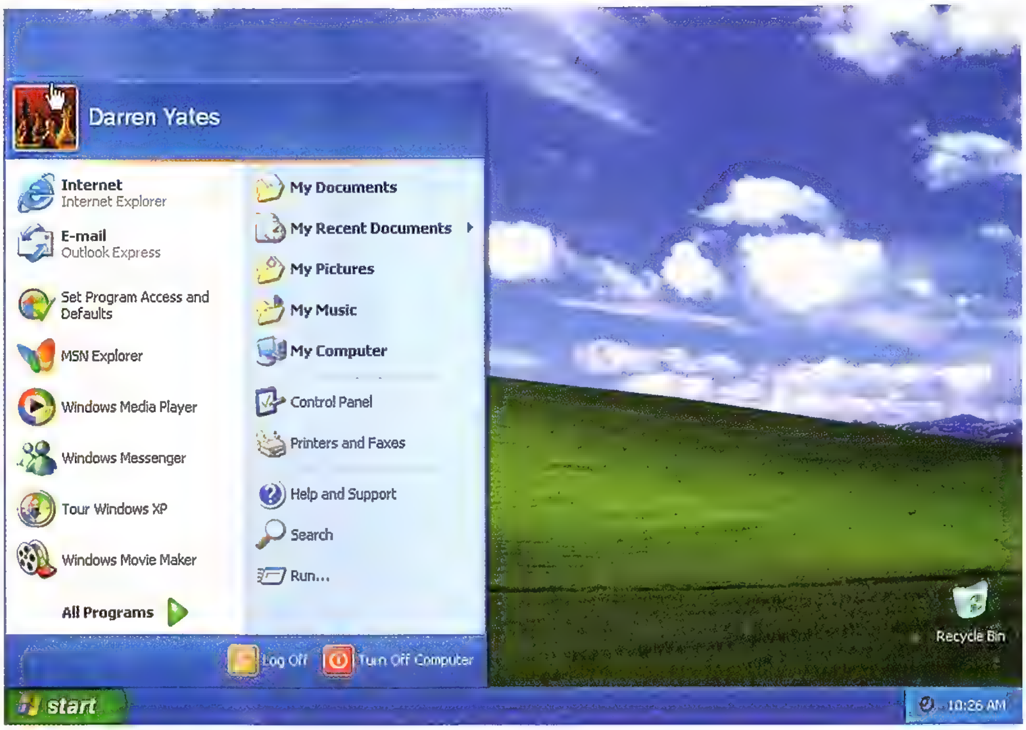


INTEL CORE 2
2006
After a bleak period in its history, Intel struck back hard with the launch of its Core 2 CPUs. They were fast, efficient and had impressive overclocking headroom too.

MINECRAFT
2009
The best-selling video game of all time by number of sales. Many consider it to be the best video game of all time. It popularised the concepts of sandbox gaming and the early access business model. As of 2021, *Minecraft* has tens of millions of active users every month.

BITCOIN
JANUARY 2009
Bitcoin was the first cryptocurrency, but beyond this, it introduced new technologies such as blockchain, decentralised peer to peer transactions and the concept of mining with commonly available PC hardware. Some say it's a Ponzi-like scam, while others say it has the potential to completely upend the basic concept of money.

GOOGLE CHROMEBOOKS
2011
Google Chromebooks, with their Google services and cloud reliance began to reinvent the entry level laptop market, particularly in the education sector.



Windows XP introduced the multimedia era for the PC.

their ability to perform computer-like roles that are indeed 'personal', from music to dating, ensured the PC would no longer hold sway as 'king of tech' in home or business.

The early-2010s were also eventful for *APC*. In 2010, *APC* launched its first iPad edition, becoming the first Australian mainstream publication to land on Apple's Newsstand app in Australia. A restructure at Consolidated Press in early-2012 brought the *APC* and *PC User* editorial teams together (and after a 16-year gap, I wrote my next stories for *APC*). Along with the rest of Australian Consolidated Press, *APC* was sold to German publishing giant Bauer later that year. However, it's fair to say technology magazines were not in Bauer's wheelhouse and the decision was made to put *APC* and new sister publication, *TechLife*, up for sale the following year. Future Publishing saw its opportunity and by October 2013, had moved the editorial team to its then-North Sydney offices. It remains the current owner today.

Windows Last?

After more than 20 years of upgrade CDs and DVDs, Microsoft changed the whole PC dynamic with the release of Windows 10 in 2015. We knew back in the early days of Windows 8 that Microsoft was working on what it described as the last version of Windows you'll buy (that said, Windows 11 has just landed). It's fair to say the PC no longer generates the same tribalism in did in decades past and Windows 10's generally silent operation has played its part.

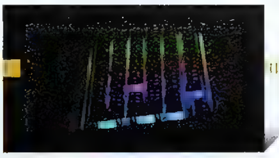
However, this just follows the evolutionary trends of the PC over the last decade. You could argue the PC is now in maintenance mode, with little in the way of recent innovation, but that would be unfair. Solid-state drives have replaced platter-based disk drives, optical drives have come and gone. In fact, the PC of today has far fewer rotating parts than 20 years ago. We've seen a rejuvenated AMD strike back at Intel, PCs shrink to the size of hard drives, and GPUs spawn mega-industries in gaming, cryptocurrency-mining, and machine-learning.

Looking forward

But there's an important virtue the personal computer and *APC* share in common – and that's the resilience to not only survive but thrive and adapt in challenging times. As COVID-19 maintains its rage around the world, global PC sales actually rose in 2020 as 'work from home' became the mantra for employees everywhere. That shouldn't surprise, since for many, the most cost-effective form of performance computing remains the venerable personal computer.

There's no doubt the pressure on independent publishers today is immense, yet just like the personal computer, *APC* continues to perform an important role within the tech landscape. Over the course of 500 issues, an Australian computer magazine has chronicled an era of unparalleled technological change, from the rise of the PC to the launch of the smartphone, from bulletin boards to fibre-optic internet, from DOS to cloud computing. Our very first issue even covered artificial intelligence. That *APC* has filled this role continuously for longer than any other PC-focused English title in the world is testament to the people who've shared the responsibility over the years for creating each issue. So here's to the publishers who paid the bills, the writers and editors who filled the pages, the subeditors who ensured everything made sense, the artists and designers who kept those pages looking good, and the businesses that supported it.

Finally, and most importantly, no magazine can survive for one issue, let alone 500, without you, the reader. So on behalf of everyone involved in *APC* over these 500 issues, thank you for your support – and here's hoping following generations will look back in another 40 years or so and celebrate the 1,000th issue of our favourite technology magazine.



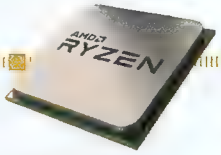
RGB
SEPTEMBER 2014

The Corsair K70 and K95 keyboards included per key RGB lighting. It wasn't long before RGB lighting permeated the entire industry. Every manufacturer was trying to out-unicorn the others. Things got really silly when RGB backpacks, chairs, and network cables were shown at Computex at 2019.

Windows 10

WINDOWS 10
JULY 2015

Windows 10 was regarded as a return to form for Microsoft, with a focus on the needs of desktop users. Improvements in security and functionality were mostly welcomed though some privacy advocates were alarmed at Microsoft's data collection policies.



AMD RYZEN
MARCH 2017

After years languishing in the shadows of Intel, AMD roared back to relevance with the release of its first Zen based CPU line. The Ryzen 1000 series offered good value, excellent energy efficiency, and highly competitive performance.

GEFORCE RTX

NVIDIA GEFORCE RTX
SEPTEMBER 2018

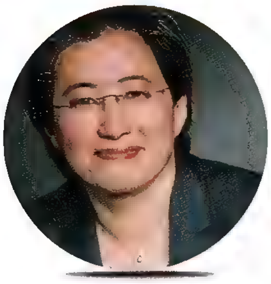
Nvidia's Turing generation GPU range introduces real-time hardware ray tracing technology, with beautiful though resource intensive results.

APPLE M1
JUNE 2020

Apple's M1 is an ARM-based SoC. It marks the beginning of the end of Intel-powered Macs. It offers very impressive performance per watt it further illustrates the ability of ARM to penetrate markets beyond mobile.

APC & THE TECH WORLD

As word spread of our big birthday, many of our friends across the PC spectrum sent their messages of congratulations.



Congratulations on reaching the 500th issue of *APC* magazine! This is truly a significant milestone. AMD is proud to have worked closely with *APC* for many years and we look forward to many more years of *APC* providing readers with great insights on the latest PC products and technologies.
Dr. Lisa Su, *President and CEO, AMD*

Congratulations, *APC*, on your 500th edition! As someone who was also there at the dawn of the PC era, it's such a treat to share my enthusiasm for technology innovation with other old-timers. Keep up the great work!
Pat Gelsinger, *CEO, Intel*

Congratulations to the *APC* team on your 500th issue! As one of the world's oldest computer magazines, *APC* has over the years produced a veritable library of insightful and informative articles, including covering Nvidia since our first GPU in 1995. Wishing you greater success as you head towards your next 500 issues.
Jeff Fisher, *GeForce Senior Vice President, Nvidia*

For the past four decades, *APC* has remained at the forefront of sharing the latest in technology news, and 500 issues is a monumental achievement that should be celebrated. The acceleration of innovation during this time is now an important part of our history. We thank the reporting and in-depth reviews from the journalists over the years who have helped explain new technology and ultimately assisted with the speed of adoption to where we are today. We are looking forward to *APC* continuing to keep everyone informed on the latest tech products and trends for many years to come.
Jeremy Senior
Vice President Consumer Electronics, Samsung Australia

GIGABYTE™

Gigabyte sends their warm congratulations to the team at *APC* mag for issue 500 and operating for over 41 years, what an incredible achievement! Cheers for always supporting the Gigabyte Aorus brand! We look forward to continue our collaboration with one of our longest media partners.
Yi-Yun Liu
Gigabyte ANZ Country Manager

Micron

On behalf of Crucial, I'd like to congratulate the staff and leadership of *APC* Magazine on an illustrious 41 years in the publishing industry and serving as the longest running English-language PC magazine in the world. Well done! We look forward to reading your next 500 print issues as well!
Rahul Sandil, *Global Head of Marketing, Micron (CPG)*

ASRock

Congratulations to *APC* Magazine for publishing its 500th issue! *APC* has been established for over 40 years and continues to bring the latest technology and information to Australian PC enthusiasts. Looking forward to the next 500 issue of *APC* Magazine.
Chris Lee
General Manager of Asrock Motherboard & Gaming Peripherals Business Unit

DELL

It's amazing to think that when this publication launched, gaming was mostly done on 8-bit home computers like the Commodore VIC-20. *APC* was ahead of the curve then and, while a lot has changed in 50 years, it's stayed there, informing Australian readers along the way. Congratulations on making it to 500, we're keen to see what's next!
Satoshi Shirato, *Head of Gaming Business, Asia Pacific and Japan, Dell Technologies*

Asus is honoured to be part of *APC*'s 41 years of excellence in the magazine business. We have always admire its unbiased and professional attitude towards the high quality content that has been delivered over the years. We believe without doubt *APC* will continue to be our top media partner in Australian in the days to come. Happy 500th *APC*.
Mia Tsai
Managing Director of Asus Australia

41 years and 500 issues – what an impressive milestone. Congratulations! On behalf of Seagate, we thank you for supporting the Australian tech industry, for challenging us and writing expertly on every topic. We look forward to celebrating the next milestone with *APC* soon.
Jeff Park, *ANZ Country Manager, Seagate Technology*

APC Magazine continues to be one of Australia's most important PC publications, always providing in depth analysis of technology's most pressing subjects and influential moments. Microsoft and the Surface brand, are honoured to have worked with *APC* over the years, seeing the magazine evolve in tandem with our own technology – starting with the very first Windows OS, all the way to the Windows 11 and the newest Surface devices of today. Here's to the next 500 issues!

Drewe Letchford
Surface Consumer Lead at Microsoft ANZ

On behalf of LG Electronics Australia, I would like to congratulate *APC* for the contribution they have made to the consumer electronics space for the past 41 years. So much has changed in our industry during the past four decades – the rise of the PC, the birth of the Internet, smart phones, lifelike displays and social media - and *APC* has been there to cover it all. With the launch of the historic 500th issue, everyone at LG wishes the publication and *APC* team continued success and look forward to the next 41 years.

Brad Reed
Head of B2B Marketing (Solutions for Business), LG Electronics Australia

Ben and the entire *APC* team has been one of the biggest supporters of Synology over the years, and it is with great enthusiasm to say that we quite appreciate *APC*'s effort in delivering content of such quality. For *APC* to reach such milestone of issue 500 is a great testament to the industry and its audience. Congratulations!

Joanne Weng
APAC Sales Director, Synology

Congratulations on your 41 years! *APC* has played such a significant part in the PC world and we thank you for that. Here's to another 40+ years!

Gillian Drivas
Marketing Manager Thermaltake

APC always provides insightful coverage on the latest industry trends and Corsair's cutting-edge technology for Australia's tech-savvy enthusiasts, and we are excited to see more quality content from *APC* in the future. Congratulations from Corsair on the 500th Edition!

Brenda Hsien
Director, Marketing APAC Corsair

For 500 issues *APC* has been an evangelist for consumers interested in all things computing technology. Congratulations to everyone who's contributed to the publication across its 41 years!

Michael Teng
HyperX APAC PR Manager

Congratulations on your 500th edition *APC*, what an incredible milestone. That's more than 40 years of celebrating everything that the PC can do. *APC*'s goal has always been the same as ours: simplifying technology to allow users to achieve exceptional things. Here's to another 500!

Raza Haider
Senior Vice President and General Manager, Global Consumer PC, Displays, Software & Peripherals, Dell Technologies

Congratulations, *APC*, on your 500th issue! What a mammoth feat to have been in print for 41 years and still going strong. You are a cornerstone magazine for us at Acer, and we look forward to another successful 500 with you.

Darren Simmons
Oceanic Managing Director at Acer

Many congratulations on this historic milestone to the entire *APC* team, both past and present! It's been D-Link's honour to be part of the *APC* story since its inception, and we look forward to being part of the next 500 issues!

Graeme Reardon
Managing Director ANZ, D-Link

Congratulations to the team at *APC* on 500 Issues! A huge achievement for a magazine to be so enduring which can only be down to the excellent quality. Thanks for all the support!

Neville Wang
Managing Director of TP-Link Australia

Congratulations on the success of *APC* Magazine and its extension from Australia to the world. To achieve 500 issues is not only a key milestone, it means *APC* magazine has been well received as it provides invaluable IT news, analyses, reviews, etc. for worldwide readers. We look forward to the 1,000s of *APC* Magazine issues in the years to come.

Ming Leu, Managing Director *i-Lan Technology trading as DrayTek Aust & NZ*

apc
HOTTEST NEW TECH 2009
Build a complete PC for $599

Pic: Richard Ogrodnik

APC READER STORIES

In the lead up to this milestone issue we received some lovely letters from our readers and their time with *APC* and their PCs. These are some of their tales.

The high-flying PC

It began with my first PC, a Tandy TRS-2 which I used in 1981 as a terminal while running a large Fortran simulation of the RAAF's Officer Corps. *Microsoft Flight Simulator* was released in 1982, and being desk-bound, I embraced it. PCs such as the Amiga improved rapidly. My RAAF rank by this time was Wing Commander, and the Chris Roberts' *Wing Commander* series really did blow my mind as promised.

Laptops became more powerful, and a friend and I used SciLab to build a simulation of the Russian V-300 Surface-to-Air Missile. We could exchange code by email that would reliably run on an Apple and a PC. Calibration required runs of 10 hours and tens of thousands of virtual rockets have been fired.

My current fascination is *MSFS 2020*. This is an extraordinary piece of work that pushes even the most powerful PC to the limits. Connection to the NBN brings greatly increased detail, live weather and aircraft. During the COVID lockdowns I'm using *MSFS 2020* to tour the world.

Where will PC technology take us next? Graphics cards and CPUs with ever more billions of transistors will open new horizons. My guess is that virtual reality will soon be indistinguishable from the real world.

What a journey! Thanks *APC*. You have been with me on this adventure for as long as I can remember.

Chris Mills

Far left: Former RAAF Mirage pilot Chris uses his PC to create experimental aircraft in X-Plane.
Left: *APC* reader Chris on the right.
Pics: Chris Mills

Bottom: *APC* readers like Austin were always pushing the limits of maximum power computing.

TOGETHER WE ARE POWERFUL

When I was young I got a music tape 'The Best of Don Spencer' during a shopping trip containing a track titled 'Super Computer'. Perhaps this event planted a seed in me, as around 2007 and the early days of Sony PS3 there was talk about clustering multiple systems together to work as one powerful system, and from that point on I have been hooked on High Performance Computing – which everyday people with home systems can contribute with.

Folding@Home is my preferred platform although there are others around including for modern mobile phones.During the 2020 COVID outbreak I sent *APC* an email suggesting a piece on distributed computing efforts to combat the disease (among others)... *APC* was already on it. In 2020 computing power donated by volunteers made Folding@ Home easily the fastest 'Super Computer' on record, and this event reinforced for many the old adage that 'together we are powerful' and that one person can make a change.

One thing I am proud of is that *APC* published a different tech tale I submitted in the September 2007 release. I have attached an image of an early foray of mine into utilising multiple systems.

Mr. Austin Dewey

Pic: Mr. Austin Dewey

apc
Windows to the MAX
25 pages of power tips for 9x, 2000, XP and Server
ATI vs Nvidia
What's your geek IQ?
Email meltdown
Mobility guide
Go wireless
DVD authoring
Inside the Kazaa raid
PCI Express
Hottest sub-$2K PCs
Dothan notebooks
ACP

Pic: Thomas Lennon

For the love of the PC

My *APC* journey started in 2004 when I was in Year 10 at high school. My story starts the year before however; in 2003 I had begun to discover the magic of computers after wondering if I could upgrade the family Compaq Presario.

I convinced my Dad to buy a DVD-ROM drive on one of his work trips to Sydney from one of the computer stores in the city. With my parent's blessing I opened up the PC and discovered a world of magic inside. I had no idea what each of the components were or what anything inside did, but from that point onwards I was determined to learn.

After successfully swapping out the optical drive in the family PC and loading up a few DVDs, I felt a surge which went on to become the beginning of a life-long interest (and career) in computing and information technology.

I had always bought gaming magazines – *Hyper*, various PlayStation magazines etc, so it was an easy step for me to take to begin buying monthly computer magazines to supplement my new found interest.

The mags I found myself buying back then were the likes of *PC World*, *PC User*, and of course *PC PowerPlay*. It wasn't until January 2004 that I picked up my first issue of *APC*; Vol 24 No 1. I still have it!

But this was the beginning of *APC* for me. Justin Kranzl and Jarrod Spiga did a great little write up comparing the ATI Radeon 9800 XT vs the Nvidia GeForce FX 5950 Ultra in this issue.

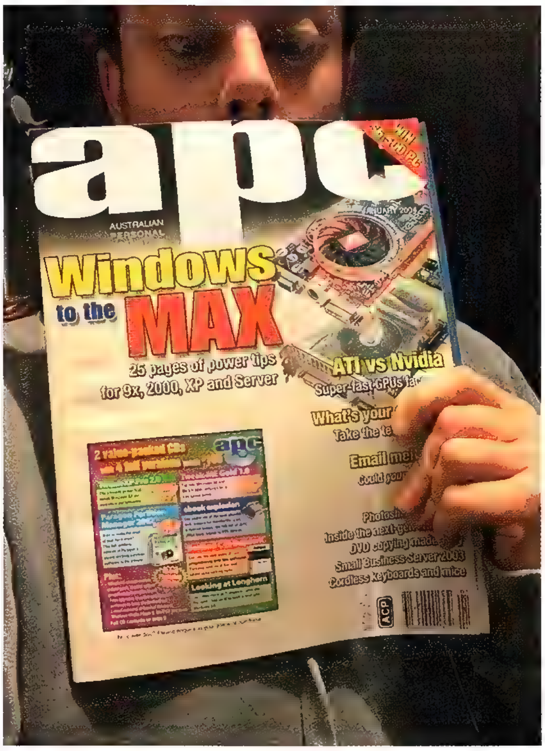
You see, computer magazines, *APC* included, for me were fundamental teaching texts for me to be able to learn the knowledge to be able to build my first PC. Before *Linus Tech Tips*, before *JayzTwoCents*, before any kind of easily accessible online PC build guides (although I had help from online forums like *[H]ard-OCP*), there were magazines like *APC* and printed motherboard manuals to help a kid like me on his way to building that first Pentium 4 or Athlon-XP system.

Now, as a big kid who has spend over a decade with a successful career in the IT industry, I still build my PCs, and continue to build for others, and I still have my *APC* subscription and learn something new from every single issue.

Thank you for all your work over the decades in putting *APC* together, and here's to a bright future ahead!

Thomas Lennon

Too hot 2 handle


apc
Windows to the MAX
25 pages of power tips for 9x, 2000, XP and Server
ATI vs Nvidia

Here's Thomas with his first copy of *APC*. Note the 'ATI vs Nvidia' story. We've all matured now and no longer buy into such rivalries...

Pics: Thomas Lennon

BACK TO BASICS

We used to buy *Australian Personal Computer* magazine in the 80s. There used to be BASIC programs in the back that you could type out. It would take many hours but we persevered on our C64.

Plenty of errors fixed later, we would have a working program to use. So much time and it probably got so little use afterwards. They are still good memories!

Tim Wilson

apc
Build a complete PC for $599
Borland Delphi 2005
apc .cd

Australian Personal Computer
apc .cd

Pics: Richard Ogrodnik

THE *APC* CD IS STILL USEFUL!

Wow, 500 *APC* editions!

Congratulations, what a milestone, it only seems like yesterday I started reading the magazine for informative and useful PC knowledge, when I received my first work PC [AT] in 1985. Still enjoying reading *APC* now, it's as good as ever, and lets me always keep up with the newest technical innovations and has heaps of practical advice. Looking forward to the next 500 *APC* editions! Well done to the team!

I also had a little hunt around in the attic at home and found a stack of *APC* discs (~150). The oldest being Dec 1998. I don't know when *APC* started adding CDs to their covers, I think that I had some older ones, but culled these a few years back and have since hung them in some fruit trees as bird deterrents.

Richard Ogrodnik

From **500** to **5,000**

Congratulations *APC* on Issue #500

In celebration of *APC* Magazine's 500th Issue, and the Lenovo ThinkStation P620, powered by the Nvidia A5000 graphics card Lenovo has asked long-time workstation customer, Fika Entertainment to imagine a future of limitless possibilities when issue *APC* #5000 comes out.

Who is Fika Entertainment?

Fika Entertainment specialise in virtual production for realtime animation using motion capture, realtime VFX (using LED and green screens), and the production of other immersive and innovative story experiences.

Our work features in a wide range of ancillary content outputs – including everything from long form content to short form platforms, digital channels, AR and VR experiences, games, apps live experiences and more.

We're using Lenovo Workstations in our work to push the boundaries of virtual production for animated and live action content. The powerful machines really help in allowing us the ability to visualise animated concepts in realtime. Meaning we can bring to life incredible possibilities for our partners and their story telling vision by providing realtime visualisation of VFX, puppeteering of animated characters through motion and facial capture, virtual environments, and virtual cameras.

ThinkStation

Introducing the

Lenovo
ThinkStation P620 (AMD)

Game Changing Power,
Limitless Possibilities

techtoday.lenovo.com/workstations

What will virtual productions look like when *APC* publishes issue #5,000?

On this trajectory, incredible things will be possible by the time we see *APC* issue 5,000. Technologies like Virtual Production will allow us to tell inspiring, interesting, and new stories in increasingly responsive, innovative and cost-effective ways - opening the door for all types of creators, perspectives, direct monetisation opportunities and imaginations to flourish in the industry.

Virtual production allows for new ways for creators to express themselves and meet the needs of audiences (global and bespoke). As these possibilities expand, we're going to reach a point where realtime graphics allow for the creation of final content straight off the stage – with no need for further post-production.

Imagine a world where realtime animation and VFX technologies become so accessible that the content experiences or special effects we are accustomed to seeing in Hollywood blockbusters or with big brands is made available to realtime content creation. This could be seen in halftime entertainment on a sports field, on stage in a school play or even at a public gathering where people could interact with each other in real-space, with a virtual avatar augmenting their appearance in real time – we're already seeing hints of this with AR shopping apps.

FIKA
ENTERTAINMENT

Lenovo has partnered with AMD to create the world's first AMD Ryzen™ Threadripper™ PRO workstation, the ThinkStation P620. Delivering the power of up to 64 cores and speed up to 4.0GHZ, the ThinkStation P620 combines legendary reliability and innovation with professional manageability and enterprise-class support. Plus, its performance-tuned and ISV-certified for multithreaded application environments, perfect for architects, engineers, scientists, geophysicists, and more.

REVIEWS

THE HOTTEST GEAR LABS TESTED

$4,399 | dell.com/en-au

Dell XPS 15 (9510)

The XPS 15 was always going to be on the best laptops shortlist, but is it still the perfect laptop pitch for creative professionals?

apc EDITOR'S CHOICE

Specifications
W10 Home; 15.6-inch 400nit OLED display at 3456 x 2160pixel resolution (16:10); Nvidia GeForce RTX 3050 Ti; 16GB RAM; 1TB PCIe SSD; 84Wh battery (6h3min 1080p movie playback)I; 344.7 x 230 x 18mm; 2kg.

Dell's XPS brand is about as reliable as they come in the laptop space, and the XPS 15 9510 has everything a creative professional is going to be looking for in a larger laptop. Dell likes to offer the full suite of customisable options for its laptops so you'll get to choose from Intel's i5, i7 or i9 11th gen CPUs to meet the demands of your workload. While you can still choose the RAM allocation and storage size on all options, if you go for the entry i5 spec you'll have to utilise the integrated Intel UHD Graphics GPU, and you can only match this option with a FullHD touchscreen for a starting RRP of $2,999.

For those needing a bit more power the i7-11800H and i9-11900H CPU options include a discrete Nvidia GeForce RTX 3050 Ti GPU and start at $3,499 and $3,899 respectively. The base models here come with the same 15.6-inch non-touch display as the i5 model, but you do have the option to upgrade this to a 3.5K resolution touchscreen OLED display for an extra $600, or a brighter 4K touchscreen LED for $567. While the 400-nit OLED display is capable of meeting the full range of DCI-P3 colours, the UHD+ monitor has been designed for creators that need to work in the Adobe RGB colour space.

As you would expect, there's a whole suite of elements that Dell has been refining over the years that really help the XPS range stand out amongst other Windows Ultrabooks. The Infinity Edge besels, pioneered by Dell, continue to push the boundaries of how frameless a screen can look and the keyboard offers one of the nicest typing experiences you'll find on a laptop. The carbon fibre keyboard surround has a nice powdery, rubber-like tactile finish that deflects heat away from your palms and keeps your hands comfortable all day.

The two more powerful configurations feature full octa-core CPUs that are going to outpace the 11th gen quad-core processors that you'll generally see on today's Ultrabooks. There's really not much these laptops won't be able to churn through, operating at near desktop-level performance and outpacing ageing units like Apple's MacBook Pro 16 (2019) by 10-15 percent in CPU benchmarks and more than 75 percent in graphical performance. While this unit isn't really designed for gaming, you can definitely get playable framerates at 1080p Ultra settings on pretty much any current game.

The Infinity Edge besels, pioneered by Dell, continue to push the boundaries of how frameless a screen can look and the keyboard offers one of the nicest typing experiences you'll find on a laptop.

Battery life is good, with theXPS 15 providing enough juice for seven hours and 32 minutes in PCMark 10's Home Work battery benchmark, and a little over six hours of continuous FullHD movie playback.

While there's clearly everything you would want as a creative professional from the higher specced models here, it's worth pointing out that you can get way better value elsewhere if you're thinking of getting the i5 model or you're not sure about pulling the trigger on one of the two screen upgrades. For these variations you could pretty easily find equivalent devices for $1,000 less. And even though you will get everything you need from the i7 or i9 touchscreen variations, Dell still likes to build a bit of overhead into its pricing so it can put them on sale from time to time.

	Dell XPS 15 9510	MSI Creator Z16
PCMark 10 - Overall (score)	6,238	6,561
Cinebench R23 - CPU (multi-threaded)	8,505	9,984
Geekbench 5 - Multi-core (score)	7,557	8,285
3DMark Time Spy (score)	4,637	6,509
Battery life - 1080p video playback (h:min)	6h03min	4h18min
Peak CPU temperature (°C)	100	100
CrystalDiskMark Read (MB/s)	3,214	6,617
CrystalDiskMark RWrite (MB/s)	2,868	5,112

An outstanding powerhouse-laptop for creatives with a pricetag to match.
Joel Burgess
★★★★☆

$1,949 | lenovo.com/au

Lenovo Yoga Slim 7 Pro 14" AMD

The original 2-in-1 bends into a new clamshell shape and the transformation might just be good enough to start a new fad.

apc
EDITOR'S CHOICE

Specifications
W10 Home; 14-inch 90Hz OLED display at 2880 x 1800 (16:10) resolution; DCI-P3, Vesa HDR 500 True Black, Dolby Vision; AMD Ryzen 7 5800H; Integrated AMD Radeon Graphics (Optional Nvidia GeForce MX450); 16GB; 512GB PCIe SSD; 61Wh battery (7h48min 1080p movie playback); 312 x 221 x 17.9mm; 1.39kg.

Lenovo's Yoga range has been steadily expanding beyond the classic 2-in-1s that the brand was founded on, so we'd forgive you for losing the Yoga Slim Pro 7 amongst all the other new clamshells, but it's actually one of the most unique configurations we've seen in a while.

Obviously that narrative all starts with the AMD Ryzen 7 5800H or Ryzen 9 series CPU that drives the Slim 7 Pro (14" AMD). These are both powerful eight-core CPUs that you generally see on gaming laptops and even the lesser of the two normally performs within 10 percent of Intel's powerful Core i9-11900H. Add 16GB of RAM and you have an impressively powerful laptop that'll tackle anything you throw at it with ease.

Lenovo has managed to compress these powerful components into a compact 14-inch form factor that's just 1.4kg and 1.8cm thick which is an amazingly portable profile. In fact, all the physical design elements are carefully engineered. The chassis materials feels premium, the hinge works well, the keyboard offers 1.3mm key travel and feels really nice to type on, and the generous touchpad is soft to touch and responsive.

All these features revolve around the 14-inch Samsung E4 OLED display that operates in a 16 by 10, 2,880 x 1,800 pixel resolution. At 243ppi this is a reasonable pixel density that gets all the rich contrast benefits of self-lighting OLED pixels while still offering a decent 600nit peak brightness. The display also gets some pretty amazing colour specs, with full DCI-P3 colour reproduction, Dolby Vision HDR and VESA DisplayHDR 500 True Black certification. This means that not only does it look fantastic during media playback and light gaming, but it's also capable of professional level colour accurate work.

If those screen specs weren't enough, the faster OLED technology means this screen runs natively at 90Hz and offers a 1ms response time, so you'll be able to run less demanding games and fast video at really smooth frame rates. The battery life is long enough as is, offering eight hours and 22 minutes of light work and seven hours and 48 minutes of media playback, but you can shift the screen to 60Hz if you want to stretch out that lifespan a little further.

If you are partial to watching or listening to media on your laptop then the 2W Dolby Atmos-certified speakers sound as good as any device we've tested. Despite being exceptionally powerful, we actually couldn't get the CPU to spike above 83-degrees, which makes it the best thermal design we've seen on this class of device in years.

There's all the latest Wi-Fi and Bluetooth specs, it's got a couple of ultra-fast USB 3.2 Gen 2 ports, and there's even a legacy USB Type-A socket and a 3.5mm audio jack. The inbuilt HD webcam and mic even have built in AI background noise tools and there's other AI-leveraged software running in the background to optimise battery life, fan speed, and temperature.

You can get faster SSDs these days, but with read and write speeds of 3,550 and 2,900MB/s, you're hardly going to get a chance to notice the difference. Really the only thing that could hinder this unit is the price, but with all the variations landing around the $2K mark you're getting plenty of bonus features for a pretty competitive price.

> *Not only does it look fantastic during media playback and light gaming, but it's also capable of professional level colour accurate work.*

	Lenovo Yoga Slim 7 Pro 14" AMD	MSI Creator Z16
PCMark 10 - Overall (score)	6,224	6,561
Cinebench R23 - CPU (multi-threaded)	10,198	9,984
Geekbench 5 - Multi-core (score)	6,859	8,285
3DMark Time Spy (score)	1,376	6,509
Battery life - 1080p video playback (h:min)	7h48min	4h18min
Peak CPU temperature (°C)	83	100
CrystalDiskMark Read (MB/s)	3,551	6,617
CrystalDiskMark RWrite (MB/s)	2,932	5,112

■

A powerful, well designed ultrabook with an awesome OLED screen for a good price. **Joel Burgess**
★★★★★

$1,649 | anz.dynabook.com

Dynabook Tecra A50-J

An enterprise laptop that means business.

Specifications
Windows 10 Pro 64-bit; 15.6-inch IPS display at 1920 x 1080 pixel display; Intel Core i5-1135G7 CPU; 8GB RAM; Intel Iris Xe Graphics; 256GB PCIe SSD; 53Wh battery (approx 7.5 hours 1080p movie playback); 35.8 x 23.7 x 1.99cm; 1.65kg.

If you're a consumer that would trade thin bezels and polished metallic finishes for a more sturdy chassis structure, or you'd swap out a gaming-capable discrete graphics card for extra long life keyboard keys then read on. If, on the other hand, you'd rather the polished features of consumer grade laptops, then you're probably going to want to stop reading and start looking elsewhere.

The Dynabook Tecra A50 is a 15.6-inch business-focused laptop that can be configured with one of Intel's 11th generation i5 or i7 quad-core laptop processors. Starting with the Intel Core i5-1135G7 CPU, 8GB of RAM and 256GB of onboard storage, the entry Tecra A50-J retails for $1,649 which isn't entirely unreasonable, but it's up there with the most expensive devices we can find with these specs. Sure this device does offer fast 3GB/s read and write speeds for its storage, but when you can get a device like the 14-inch Acer Swift 3x with an 11th gen i7, a 1TB 2GB/s SSD and an Intel Iris Max GPU for under a $1,000 it makes the Dynabook Tecra A50 seem pretty expensive. If you do absolutely need that 15.6-inch screen then you'll even find tens of laptops from Acer, Asus, HP, Lenovo and MSI for hundreds of dollars cheaper too. If that pricepoint's fine you can even find higher-specced units than the Tecra A50-J with more powerful components or OLED screens.

The other end of the Tecra A50-J range comes with an Intel Core i7-1165G7 CPU, 16GB of RAM and a 512GB PCIe SSD for $1,999. While this is more competitive than the i5 model it's still not exactly a bargain when you consider it only offers a FullHD display. Again there's plenty out there that are less expensive or offer more consumer-focused features.

The Tecra A50-J is actually rather sleek for a Dynabook laptop. It's got a nice polished metal finish, it's under 2cm thick at its chunkiest point, and it weighs in at a very portable 1.65kg. It is a little thicker and heavier when you compare it to leading Ultrabooks, which are generally between 1.5-1.8cm thick and around 25 percent lighter, but this bigger profile does mean it can fit multiple USB Type-A ports, an Ethernet socket, a HDMI interface, a Security Lock and a Smart Card slot. Yeah, we had to look that last one up too – the Smart Card slot is a hardware-based, two-factor authentication feature that is used by some larger enterprises.

If it wasn't clear enough already that this laptop is wearing business socks, it's also got its own BIOS, MIL-STD-810H durability certifications, Windows 11 ready Trusted Platform Module v2.0, a fingerprint reader, webcam shutter, Intel Authenticate business-grade security, supervisor passwords and an IR face recognition camera to remind you to get back to work.

We didn't actually get a chance to benchmark the battery life ourselves, but the more efficient quad core processors combined with the 53Wh battery should at least get close to a full working day of longevity.

Performance benchmarks for the i5 model were roughly where you'd expect although they were a little disappointing in PCMark 10, scoring behind a Microsoft Surface Laptop Go with a 10th gen Intel i5 CPU.

The Dynabook Tecra A50 is a 15.6-inch business focused laptop that can be configured with one of Intel's 11th generation i5 or i7 quad-core laptop processors.

	Dynabook Tecra A50-J	Microsoft Surface Laptop Go
PCMark 10 - Overall (score)	2,900	3,278
Geekbench 5 - Multi-core (score)	4,611	3,326
Geekbench 5 - Single-core (score)	1,471	1,186
Geekbench 5 - Open CL (score)	13,529	5,703
Battery life - 1080p video playback (h:min)	07:38	04:16
Peak CPU temperature (°C)	98	99
CrystalDiskMark Read (MB/s)	3,532	2,020
CrystalDiskMark Write (MB/s)	2,626	826

Dynabook's Tecra A50-J is all work no play, so it's only really the best bet for those looking to upgrade a fleet of company laptops.

Joel Burgess

★★★☆☆

$13,270 (as configured) | www.lenovo.com.au

Lenovo ThinkStation P620

Threadripper goes Pro.

apc
EDITOR'S CHOICE

AMD's Threadripper CPUs have really shaken up the HEDT market. While they're very strong when measured against mainstream desktop-class hardware, their I/O is handicapped when compared to AMD's Epyc range. Threadripper Pro bridges the gap between the two. The Pro range includes support for 8-channel ECC memory and up to 128 PCIe 4.0 lanes. Lenovo is the first company to offer Threadripper Pro systems, and impressive systems they are. In fact, they are the first AMD-based ThinkStations from Lenovo full stop.

The Lenovo ThinkStation P620 is compact tower system that's exceptionally well put together. It can weigh up to 24kg, yet it remains easy to work with thanks to a largely tool-less design. This isn't a bunch of components thrown into a rebadged case. The whole system has been engineered from the ground up, including a custom form factor PSU that plugs directly into the motherboard, without any cables. It's full of lovely little touches and attention to detail.

Our system came equipped with a 3945WX 12c processor, 4x16GB of DDR4-2933 and a shockingly high-end Nvidia RTX A6000 GPU, complete with 48GB of GDDR6 memory (note that the Quadro branding has been dropped). The 3945WX doesn't stress the custom cooler, though it may get a bit noisy with a high core count option. Speaking of options, Lenovo offers a huge range of configurations. Which one you go for will depend on your specific workflows. Professional users across a variety of fields including everything from data processing or engineering to visual effects and software development will find a P620 configuration to suit.

You could equip it like our sample, with a relatively low-end CPU and ultra-high-end GPU, but you'd only do that if your software is optimised and certified for the Ampere-based A6000. 48GB really opens up a lot of GPU processing possibilities. Alternatively, you could go with a 64C 3995WX and a low-end GPU if your software relies on CPU threading. Whatever you go for, the ability to expand your system with extra GPUs, co-processors or any other suitable PCIe card without compromise is a real strength of the WRX80 platform. All those PCIe lanes mean the P620 provides expansion potential that few 1P workstation systems can even get close to matching.

Apart from PS/2 keyboard and mouse ports, the P620 omits legacy ports (though a COM port is optional). You get plenty of USB 3.2 10Gbps ports and Aquantia 10GbE as standard. There's a useful CD/DVDR burner too. It comes with a mouse and keyboard and a there's a three-year on-site warranty, which is a great value add.

Our sample P620 with its 3945WX isn't supposed to dominate CPU-based workloads. It's more designed to be a vehicle for the RTX A6000 or other expansion options. In tasks that make use of the power of the A6000, it's very fast indeed. You can add a second for even better performance.

The ThinkStation P620 is clearly a highly refined and well-engineered system. With list prices ranging from around $4,500 to well over $40,000 for a 64c 3995WX and dual A6000 powerhouse, these aren't systems for everyone, but if you've got the tasks to make use of all that power along with the budget to pay for it, then you'll love the P620. 1P workstation systems don't get much better than this. Well done Lenovo.

Specifications

AMD Threadripper Pro 3945WX CPU; 4x16GB DDR4-2933MHz ECC Memory; Nvidia RTX A6000 48GB ECC GDDR6 GPU; Samsung 512GB NVMe SSD, DVD/CD Reader/Writer; 129.74 x 382.73 x 396.39 mm.

	Lenovo ThinkStation P620
Handbrake Video Encoding - avg FPS	63.65
Cinebench 20 - Multi thread Score	7,087
Blender 2.92 Classroom CPU - Time (seconds) Lower is better	339
Blender 2.92 Classroom GPU (CUDA) - Time (seconds) Lower is better	59
Blender 2.92 Classroom GPU (Optix) - Time (seconds) Lower is better	37
PugetBench - Premiere Pro	1,136
PugetBench - Photoshop	1,004
Geekbench 5 - Single Core	1,293
Geekbench 5 - Multi Core	14,124
Geekbench 5 - Cuda Compute	236,153
Passmark - Overall	7,725
Passmark - CPU	34,398

■

Configuring the Lenovo P620 to suit your workflow will deliver awesome performance along with incredible expansion potential.

Chris Szewczyk

★★★★⯪

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Powercolor Radeon RX 6600 Fighter

Affordable 2021 GPUs at last?

Specifications
Powercolor Radeon RX 6600 XT Fighter; 1792 Shader Cores; Up to 2491MHz Boost Clock; 8GB 14Gbps GDDR6 memory, 224GB/s Memory Bandwidth; 3x DisplayPort 1.4a, 1x HDMI 2.1; 1x 8-pin Power Connector; 132W TDP.

Hot on the heels of the RX 6600 XT comes a more affordable Navi 23 variant: The RX 6600. Ever so slowly, there are current generation cards that can be considered affordable, if only relative to grossly overpriced higher end cards. If you're suffering with an older card that's on its last legs, or you're looking for something that lets you run all titles at 1080p, the 6600 is a card that could satisfy your needs. Is affordable really affordable, though?

The RX 6600 contains the Navi 23 GPU, which it shares in common with the 6600 XT. Its 237mm² die contains 1792 Stream Processors compared to the 2048 of the 6600 XT. You get a 128-bit memory bus with 14Gbps GDDR6 memory that provides 224GB/s of bandwidth. It is, by most measures, what we'd call a budget-tier gaming GPU.

Like its XT sibling, the 6600 makes do with a PCIe x8 interface. This applies to both PCIe 3.0 and 4.0 boards. At this end of the market it's not a real issue, but we can't get used to the idea of $500+ GPUs having such limitations. A PCIe 8x card with a 128-bit bus and 237 mm² die doesn't seem deserving of such a price.

With no reference card for this release, AMD sent over Powercolor's RX 6600 Fighter. It's very much a budget card, and may end up being one of the cheapest of all 6600 cards. That's not a bad thing though, as a card with a 132W TDP simply doesn't need a monster triple fan cooler. It's very compact; it contains just one 8-pin power connector and it has 3x DP 1.4 and a single HDMI 2.1 port. It's a card that does the basics and it's one you'd likely install out of sight and out of mind. There's no RGB or fancy branding. For a budget card, that's fine by us. It features a boost clock of up to 2,491MHz, though our sample settled into a long-term boost clock of 2,262MHz.

The 6600 is designed to be an RTX 2060 or 3060 competitor. We found it to trail the 3060 more often than not, but given the 3060 is selling for an insane $1,000+, the Powercolor Fighter, at a supposed $549, offers much better value for money, and with lower power requirements too. Those low power requirements don't stress the basic cooler either. Though it can be heard when it ramps up, it's far from bothersome. With a reported maximum of 59c, it's certainly a cool running GPU.

The 6600 sits in a strange market position. Nvidia doesn't yet have a 3050 class card to go against it. The likes of a 2070 would compete well, but they're unavailable outside of second-hand markets. Our conclusion is similar to the one we had for the 6600 XT. It's a good 1080p card that should be a compelling option for a budget gaming rig, but only if its price doesn't blow up. At $549 it's definitely a better buy than a 3060, but then we all know it's going to cost more than that, such is the ridiculous state of the GPU market. If the price can remain under $600, then AMD could have a winner on its hands. ■

	Nvidia GeForce RTX 3060	AMD Radeon RX 6600
Metro: Exodus - 1920x1080 Ultra Preset (Avg fps)	64.3	64.1
F1 2020 - 1920x1080 Ultra High Preset (Avg fps)	138	144
Middle Earth: Shadow of War - 1920x1080 Ultra Preset	108	98
Total War: Warhammer II - 1920x1080 Ultra Preset (Avg fps)	84	74
Ghost Recon: Breakpoint - 1920x1080 Ultimate Preset (Avg fps)	78	80
Shadow of the Tomb Raider - 1920x1080 Highest Preset (Avg fps)	115	99
Temperatures © Idle	38	39
Temperatures © Load	63	59
3DMark - Time Spy Extreme	4,209	3,906

AMD could have a very good card on its hands, but only if that $549 price holds. Time will tell.

Chris Szewczyk

★★★★☆

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Powershield Gladiator 1500 UPS

Insurance for your winning ways.

Specifications
Capacity: 1500VA / 900W; Voltage: 240 VAC; Voltage range: 170-280VAC; Transfer time: 6ms typical, 10ms max; Outlets: 6 x Australian outlets with surge and battery backup; USB charger: USB-A and USB-C 5V / 3 Amp; Surge protection: 1140 Joules / 30,000 Amps.

The Gladiator from Australian UPS manufacturer Powershield is designed for gamers. How can this be? Power is power, no matter how it's being used.

No one can argue that gaming – for the serious many – is truly a mission-critical function. This is true of PC and console. If I had a shutdown on the last few laps while winning a sim race, or was one of the remaining few in a Battle Royale game, I'd be devastated if the world went dark right on the cusp of my mighty glory. A UPS will keep you in the game for precious minutes, and for pro-eSports gamers something like this would be essential.

But what are the gamer-specific aspects in this UPS? Powershield has added two features to this box to game it up. First, the obligatory RGB, which is tastefully executed as a thin line circling the front, and is customisable. Secondly and more actually useful is an LCD display that displays essential info, including input voltage and frequency, battery voltage and capacity, plus naturally backup time remaining. That's not uncommon for a UPS, but even gamier – you can connect the PC via an included USB cable, install an app and the panel can now show CPU speed, temperature, and load.

This display feature is nice, but a UPS is usually tucked away out of sight. This one is intended to be seen, and its big party trick is that the LCD display module is removable, and functions wirelessly. The module slides out easily and can be placed up to 6m from the main unit – so, one more lovely little illuminated info screen to place in your battlestation cockpit. It'll work for around two hours before needing a recharge.

There's also handy USB-C and USB-A charging ports on the front.

Up to six devices can be connected – and they all also enjoy surge protection for up to 30,000 Amps. Powershield claim the following runtimes: gaming laptop = 29 minutes, gaming PC = 15 minutes, Xbox One = 42 minutes, Xbox One X = 32 minutes, PS4 = 36 minutes,, PS4 Pro = 35 minutes. In testing on an 11900K, 3080Ti PC with a 24in screen, we saw 23 minutes of reserve power at the desktop with light loads, and we matched the claimed 15 minutes while in game.

Operationally there's no meaningful running cost. Once the batteries are fully charged the battery charger's draw is negligible (1-2W) compared to the power consumed by the gaming PC (average 500W). With its fans running it does make some noise, about the same an as average PC running under a medium load.

It's a good UPS, though value is a concern. A similarly specced (1500VA/900W, pure sine wave) non-gamer UPS can be had for half the price, or less, and it will offer the same protection.

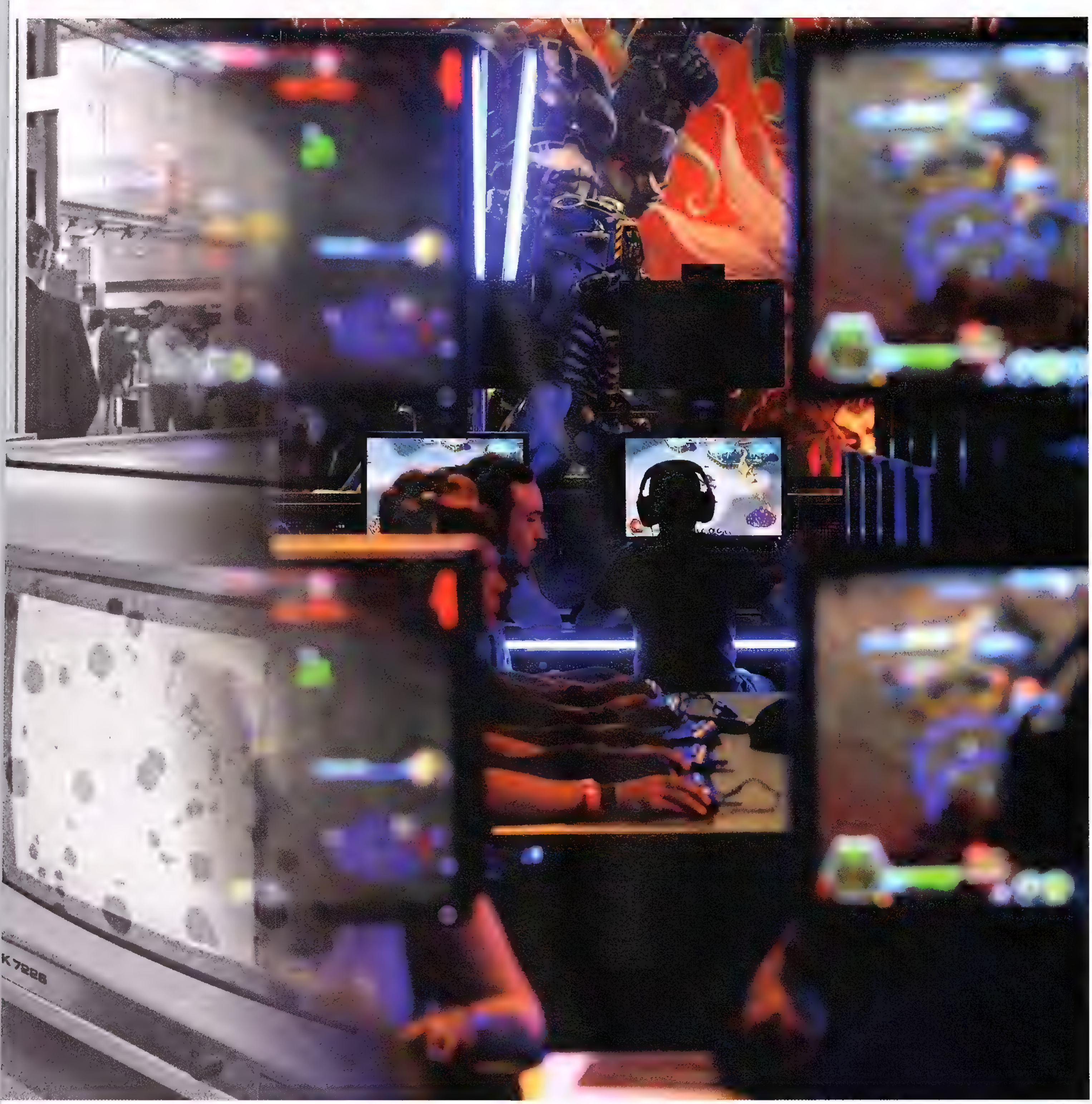
> *If I had a shutdown on the last few laps while winning a sim race, or was one of the remaining few in a Battle Royale game, I'd be devastated if the world went dark right on the cusp of my mighty glory.*

A UPS made to be seen, with good specs and the detachable LCD module is pure gaming style.
Ben Mansill
★★★⯪☆

robotron EC 1834
robotron K 6314

THE NEXT-GEN PC

PC tech standards are constantly changing. Christian Guyton breaks down what to expect from the next generation of computer hardware.



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When you actually examine how industry standards for connectivity and hardware performance evolve over time, it's surprising how quickly the new normal gets adopted by the masses. USB-A was the dominant form of physical port connectivity across the hardware spectrum for years, but mobile devices ran through a flurry of alternate compact ports before settling on the USB-C connector we know and love.

It's strange to think that in a few short years, the top-tier hardware we feature here in 2021's issues of *APC* will be heavily outdated, even obsolete. The industry moves fast. When a new gold standard for any aspect of our systems arrives, it doesn't take long before every new product conforms to the norm. PCIe 4.0 SSDs were hailed as a revolution when they first arrived, exclusive to AMD systems, but Intel has since climbed aboard and heavy hitters such as Samsung have pushed the medium to further heights than the first wave of Gen4 drives could ever reach.

But what comes next? There are plenty of upgrades already in the works, from the next generation of PCIe technology to new DDR5 desktop memory. We're going to analyse where the industry is going next, how soon it's going to get there, and what you can do to make yourself and your hardware as ready as possible.

We'll start with PCIe, or 'Peripheral Component Interconnect Express'. A bus standard that is commonly found as an interface on motherboards, PCIe connections support a wide variety of components, such as GPUs, SSDs, and Ethernet adapters. The electrical interface provided by the PCIe specification supports other existing standards within the PC hardware industry, including SATA and M.2.

PCIe specifications are developed by the PCI Special Interest Group, a consortium of over 900 tech companies with a vested interest in the technology. The standard is currently in its fourth iteration, although it replaced the original PCI bus standard, which went through five full revisions itself (from PCI 1.0 through to PCI-X 2.0). These standards are constantly evolving; PCIe may birth an entirely new bus format in the not-too-distant future.

For now, we know what to expect from upcoming versions. The specifications for PCIe 5.0 were finalised and released by the PCI-SIG in May 2019, after two years of internal research and development. Preliminary specs for PCIe 6.0 were announced just three weeks later, but this is still in the early testing phase. PCIe 5.0, on the other hand, has already entered production.

In late 2019, Chinese company Jiangsu Huacun Electronic Technology revealed the world's first PCIe 5.0 controller, named the HC9001. Chip manufacturer Rambus announced the completion of a PCIe 5.0 interface in 2020, with others following suit. These technologies are not yet available for use in conventional computer systems, but they aren't far off. AMD stated last year that it expects to have PCIe 5.0 compatibility baked into its 5nm Zen 4 processor architecture, with compatible drives arriving for consumers in 2022.

PCIe 5.0 tech is already poised to take over a number of enterprise sectors, from cloud computing to supercomputers. NAND flash controller producer Silicon Motion isn't quite as optimistic as AMD, saying it expects enterprise-grade SSDs to be available in 2022, with consumer models a little further down the line. Marvell announced earlier this year that it has completed its first PCIe 5.0 SSD controllers under the Bravera product line, which are capable of up to 14GB/s read and 9GB/s write.

Speed demons

What does PCIe 5.0 actually mean, though? The main benefit here is staggeringly fast speeds; 5.0 offers effectively double the data transfer rate of 4.0, as 4.0 did for 3.0. The link speed is 32GT/s (that's 'giga-transfers per second') compared to PCIe 4.0's 16GT/s, which in practical terms translates to an aggregate bandwidth of a whopping 128GB/s on a standard sixteen-lane interface.

These 'x16' interfaces are found on most modern motherboards for GPUs and other expansion cards, and real-world speeds are likely to be around 126GB/s to account for the overhead penalty in data encoding – this is around 2 percent, as PCIe interfaces from 3.0 onwards use a 128b/130b encoding scheme. The theoretical speeds are even higher, but that would require a 32-lane interface, which are extremely rare and unlikely to become common on consumer products for quite some time.

PCIe version bandwidth

	Link speed (GT/s)	x16 bandwidth (GB/s)	Lane bandwidth (GB/s)
PCIe 3.0	8	32	1
PCIe 4.0	16	63	2
PCIe 5.0	32	126	4

126GB/s is an incredibly fast transfer rate for an interface that could power desktop graphics cards and drives. PCIe 5.0 M.2 SSDs are likely to become available in the next few years, but will require a processor and motherboard with Gen5 compatibility to perform at its peak. M.2 interfaces use a four-lane connection, which will see the potential maximum transfer speed for SSDs rise from 8GB/s to 16GB/s when Gen5 drives arrive.

> If you think 'that's much faster than I need!', you're probably right. PCIe 5.0 drives will be monstrously fast, but Gen4 SSDs are already nippy.

What do you want?

If you're thinking 'that's much faster than I need!', you're probably right! PCIe 5.0 drives will be monstrously fast, but Gen4 SSDs are already seriously nippy, you're looking at read speeds of up to 7GB/s and write speeds of up to 5.5GB/s. That's fast enough to make regular file transfers and load times in games trivially quick.

Upgrading to a Gen5 drive that offers 16GB/s read speeds – or more likely something in the realm of 14GB/s for the first wave of PCIe 5.0 SSDs, as manufacturers perfect the controller hardware – might make a difference, but you won't notice it unless you routinely move massive files around on your PC. Games might load half a second faster, but that's not really a big deal if they already only take two seconds to load.

Power draw on PCIe 5.0 drives is expected to be a lot higher than their Gen4 counterparts, although this is based on current non-consumer products being tested and the thermal performance will likely be refined before we can get our hands on them. Gen5 SSDs are also expected to have superior lifespans compared with previous generations, but again, most SSDs will already last until they're decidedly outdated.

We'd advise holding off on upgrading to PCIe 5.0 unless you regularly need to shift large amounts of data; even then, when it comes to uploading to a network, you're going to be bottlenecked by your internet speed long before your drive starts to struggle. Maybe in several years, games will be big enough to need PCIe 5.0 drives for speedy load times, but that's likely a long way off yet.

Doubled data

Moving on from PCIe, let's take a trip down memory lane, literally; we're looking at RAM, specifically DDR5. That's

Eight-stick kits like this could be a thing of the past with DDR5's increased capacity.

DDR5 SDRAM, the kind used for actual system memory, rather than the memory found in graphics cards (graphical memory is currently in its sixth iteration, GDDR6). A quick note on graphical memory; while GDDR7 or a similar upgrade is bound to arrive eventually, the limits of GDDR6 are still being pushed and we shouldn't expect to see it announced anytime soon.

DDR5 SDRAM – the mouthful that is Double Data Rate Five Synchronous Dynamic Random-Access Memory – is the next generation of desktop RAM. The prevailing industry expectation is that most systems using DDR4 memory will migrate to fifth-generation SDRAM in the future, but how long will that take?

DDR5 memory has been in production for a while now, with members of JEDEC (the Joint Electron Device Engineering Council, a similar conglomerate to the PCI-SIG) announcing work on DDR5 chips as far back as 2017. The standard was delayed from its original planned release in 2018, and was officially released in late 2020 with the launch of the world's first proper DDR5 RAM by Korean semiconductor giant SK Hynix.

Much like PCIe 5.0 products, DDR5 isn't commercially available yet for hardware tinkerers. The same goes for LPDDR5, the low-power memory variant designed for use in laptops, tablets, and smartphones. Although Team Group has released a kit of consumer DDR5 RAM, it's prohibitively expensive and effectively unusable until processor and motherboard manufacturers release compatible boards, hopefully before the end of 2021.

Powered up

So, what can we hope to see from DDR5 memory? For starters, the memory speed is almost comically fast. The base frequency of DDR5 RAM will be 4,800MHz (that's technically 2,400MT/s, thanks to the doubled data rate), with potential for a ceiling of 8,400MHz or higher, although initial products are expected to launch with a cap of 6,400MHz until upgrades to the specification can be implemented as they were in previous generations.

With comparable latency to DDR3 and DDR4, that puts base memory speed of DDR5 RAM above the vast majority of memory kits currently available for consumers. It is expected that high-end DDR5 kits will run at speeds exceeding even the most aggressively overclocked DDR4 memory. Chinese memory manufacturer Netac teased the development of a 10,000MHz kit this year.

Memory capacity per DIMM slot is also being boosted, doubling from 64GB to 128GB. If we see consumer motherboards with the capacity for eight DIMMs as we have for the DDR4 generation – these are rare, with four or two slots being much more common, but motherboards such as the Asus ROG Rampage VI Extreme Encore offer eight memory slots for extreme performance – there is potential for monstrous 1,024GB system builds. Imagine how many Chrome tabs we could open with that kind of power...

Is that necessary? Heck no. But the implications are clear; 32GB and 64GB sticks will become more common, raising the bar in particular for compact systems. Being able to easily slap 128GB of memory in an ITX system with only two DIMMs is a huge potential boon, although we've yet to see the software and gaming industries step up to demand such huge amounts of RAM for common computing processes.

One of the most interesting benefits offered by DDR5 is the lower operating voltage of 1.1V, compared with 1.2V in the current DDR4 memory. This results in lower power consumption per DIMM despite the improved performance, which will certainly be a boon for watt-hungry machines.

DDR5 sticks can potentially have voltage regulators built directly into each unit, further boosting data speeds by rapidly adjusting the voltage supplied to the RAM chip on the fly, but this is liable to make manufacturing costs skyrocket. Don't expect to see this feature in standard consumer chips, although we won't be too surprised if kits aimed at overclocking enthusiasts surface.

Tech tricks

The DDR5 standard has several clever inclusions that promise to boost performance compared with previous generations.

Caldigit's Element Dock was one of the first USB4-powered hubs to hit the market.

© CALDIGIT

PCIe 4.0 drives felt insanely fast when they first arrived, but they'll soon be overshadowed.

One of these is a nifty technique called Decision Feedback Equalisation. In simple terms, DFE allows for performance improvements by stabilising data transfers within the DIMM itself and between the memory and CPU.

Looking at DFE in greater detail reveals exactly how it benefits memory performance. With standard SDRAM, signals are sent across the motherboard PCB between the CPU and RAM, with a degree of dielectric loss occurring in the process. This introduces minuscule imperfections in the signals received by the memory, referred to as intermodulation distortion.

DFE circuitry in DDR5 memory introduces a compensating filter that analyses the distortion and produces a 'counter-signal' that cancels the frequency variation, resulting in a more ideal channel response. Less distortion allows for higher memory I/O speeds, which means greater bandwidth. DFE isn't the only equalisation technique used in modern RAM, however, it does represent a significant step forward in performance for DDR5; new memory using DFE should be able to achieve a bandwidth of up to 51.2GB/s per module.

Another pair of features for correcting potential lapses in memory performance are ECC and ECS: that's Error-Correcting Code and Error Check and Scrub, respectively. These are essentially baked-in memory chip functions that search for errors as they occur and rectify them before sending the data to the processor. Some specialised DDR4 kits have previously included ECC tech, but both ECC and ECS are part of the DDR5 memory standard.

ECC-enabled DDR5 RAM will contain separate data lines for the sending of error data to the CPU, allowing additional issues to be corrected by the processor in the nanoseconds of data transit time between the components. This means that DDR5 systems will benefit from improved overall memory stability compared to their DDR4 predecessors.

Micro-USB and Mini-USB are already on the way out; could USB-A be soon to follow?

Leaks aplenty

What hardware will you need to run DDR5 memory? Well, you won't have any hardware that can run this new memory yet; this isn't a case of simple BIOS firmware updates to accommodate a next-gen CPU. Thanks to a bevy of roadmap leaks (and eventual official announcements), though, we do have a rough idea of when to expect the arrival of DDR5-compatible hardware.

Intel's 12th-generation Alder Lake CPUs will use a hybrid architecture under the new 'Intel 7' process and are expected to launch later this year. The upcoming Sapphire Rapids CPUs (the 7nm Xeon equivalent of Alder Lake, for large-scale business use in servers and supercomputers) will be released later, projected for early 2022. Both will support DDR5 memory, meaning that Intel is almost certainly going to beat AMD to the punch.

Team Red might have a flashy new 5nm architecture planned for Zen 4, but those chips (presumably presented to consumers as sixth-generation Ryzen) aren't expected to release until 2022. Less information is currently available on Zen 4, but it will undoubtedly support DDR5. Some more tantalising insider info points to Zen 3+ APUs coming sooner with DDR5 compatibility, but all this should be taken with a pinch of salt, as it hasn't been officially confirmed by AMD at the time of writing.

Naturally, motherboard manufacturers will have to keep up with the pace. Current-generation motherboards for both Intel and AMD processors – that's Z590 and X570 respectively – don't support DDR5 natively, and news on backward compatibility is patchy. We can probably expect Z690 and X670 chipsets to arrive in late 2021/early 2022, coinciding with the release of next-gen CPUs. There's not necessarily any guarantee they'll be called that, of course, but it's easy enough to extrapolate naming conventions.

Port problems

Speaking of naming conventions, we'd like to have some stern words with the bosses of the USB Implementers Forum. After generations of USB 2.0, USB 3.0, USB 3.2, and so on, we've

Past & present USB standards

	Nominal speed (Gb/s)	Encoding (b)
USB 3.2 Gen 1x1	5	8/10
USB 3.2 Gen 2x1	10	128/132
USB4 Gen 2x2	20	64/66
USB4 Gen 3x2	40	128/132

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RAM Specifications

	Voltage (V)	Bandwidth (GB/s)	Base data rate (MT/s)
DDR3	1.3/1.5	17	800-2133
DDR4	1.2	25.6	1600-3200
DDR5	1.1	52.1	3200-6400

now got a hot new USB standard incoming. Any sane individual might naturally assume this would be called USB 4.0, or perhaps USB 3.3, depending on how much of a technological jump forward the new specification represents.

Nay, says the USBIF. Chiefs of tech titans such as Microsoft, Apple, Intel, and others have convened, and in their infinite (read: extremely finite) wisdom, have deigned to name this new standard 'USB4'. No .0 here, not even a space or a dash after the B. Nonsense, we say, but what can you do?

The blueprints for the USB4 specification were released over two and a half years ago in February 2019, and USB4 products are already in circulation, albeit in a somewhat limited capacity. Some 11th-gen Intel products have USB4, and USB4-compatible docks are available to purchase. Branding has been broken up into 'USB4 20Gbps' and 'USB4 40Gbps', which are actually USB4 Gen 2x2 and Gen 3x2.

40Gbps throughput means that USB standards have properly caught up to the plucky young upstart that is Thunderbolt, with both Thunderbolt 3 and 4 sharing that same speed. In fact, USB4 represents the closest we've come so far in merging the two interfaces; Thunderbolt 4 mandates the use of USB4 and its full feature set, so any Thunderbolt 4 product will have full USB4 support (although annoyingly the reverse is not true, as we witnessed with USB-C 3.2 and Thunderbolt 3). Intel's somewhat unexpected rollback of royalty fees for using Thunderbolt was a key factor here, opening up the format for other manufacturers.

DFE circuitry in DDR5 introduces a filter that analyses distortion and produces a 'counter-signal' to cancel the frequency variation.

Goodnight, sweet prince

Yes, you read that right: USB4 is switching over to the same physical connection standards as Thunderbolt 3 and 4, marking the death of the humble USB-A port. It's USB-C from here on; no longer will we struggle with inserting flash drives the wrong way up. No longer will we suffer with non-uniform display cables! Cast off your chains! The revolution is here!

Yes, this will probably lead to some confusion unless the USB and Thunderbolt interfaces are eventually unified; a USB-C port on a laptop right now could be USB4, or Thunderbolt 4, or Thunderbolt 3, or USB 3.2... checking specification sheets for products has always been a must, but this makes it more necessary than ever.

The maximum speed of 40Gbps won't be available on all USB4 products; budget laptops and their ilk are likely to feature the slower 20Gbps ports. This has to do with the available USB lanes for data transfers. USB4 specifies eight lanes in a standard connection, four for input and four for output. Each lane offers 10Gbps of potential data transfer speed, adding up to a 40Gbps maximum in either direction.

The interesting thing about USB4 is that as a bus specification, it doesn't just provide a simple mechanism for data transfer. Much like Thunderbolt, it can be used to provide tunneling for different protocols, most significantly DisplayPort 1.4 and 2.0. USB4 connectors will be a viable option for display daisy-chaining, with a theoretical maximum transfer performance of 8K at 60fps with HDR10 colour enabled.

USB4 cables can achieve this thanks to mono-directional connections, which means that data is only sent in one direction (in this case, from the output system to the monitor), enabling all eight data lanes to be used simultaneously, achieving a transfer speed of 80Gbps, double the USB4 standard. This is only possible with select monitors that are capable of supporting alt-mode DisplayPort 2.0 via USB-C, though.

USB-C ports on new, USB4-compatible devices will have full backward compatibility (albeit at the slower speed afforded by whatever USB-C connector you use). Consumer motherboards for custom PC builds that support USB4 and Thunderbolt 4 are only just starting to seep through the cracks, with Asus's ProArt B550 Creator board being a prime example.

Even though USB4 adoption is still in the early stages, Asus was particularly keen to get ahead of the curve, since USB4 and Thunderbolt 4 are likely to become the prevailing industry standards within a few years.

Power delivery is obviously also a feature here, as seen in previous Thunderbolt interfaces. Using the USB PD format ('PD' stands for 'power delivery'), a USB4 connection can sustain up to 5A of current or 48V of voltage, though not simultaneously. In real-world terms, USB PD is limited to delivering 100W of power at a time, with varying configurations of current and voltage. Minimum values of 1.5A and 5V are applied.

Whether USB4 could be used for greater power delivery in the future is still up for debate, as thermal limits will quickly become a problem. A USB4 interface could theoretically deliver up to 240W of power, but we aren't likely to see any hardware capable of hitting those figures anytime in the near future.

Getting set

USB4 is a far more prominent change to the way we build our PCs than the likes of PCIe 5.0 and DDR5. While the last two are more about ensuring your motherboard and processor are up to date, a fully USB4-supported custom build will require an appropriate case I/O as well as matching internal components.

The eventual widespread implementation of USB4 and Thunderbolt 4 will also likely have a knock-on effect on the design of PC peripherals. Despite the format's current dominance, USB-A connectors are liable to die out eventually, mandating either a system upgrade for better USB-C connectivity or the cumbersome use of numerous adapters. Expect products such as headsets, keyboards, and even monitors to slowly shift to USB-C as a primary wired connection format in the coming years.

Given that pre-built USB4 products are already on the market, it's a safe bet that we'll see support for the new standard in PC components fairly soon. If you're a fan of wireless setups (we love a good Bluetooth mouse), you might not need to worry, but if your I/Os see heavy use we'd advise you to wait until compatible parts are available before doing any major system upgrades.

Blue teeth

DDR5, PCIe 5.0, and USB4 might be the most pertinent new standards we can expect to see rising to prominence in the near future, but that's not all there is to look forward to. New connectivity standards are always in development; Bluetooth is due an update, with the most recent new format (Bluetooth 5.2) released back in 2019 – and that was merely a refinement of the five-year-old Bluetooth 5 standard.

Will we see Bluetooth 6 next, or merely Bluetooth 5.3? Previous trends suggest it will be the former; every preceding generation of Bluetooth technology has stopped short of a .3 iteration, with the Bluetooth Special Interest Group typically pushing ahead with a new standard after one or two updates.

What could the sixth iteration of Bluetooth tech look like, then? We're firmly in speculative territory here, but reduced battery consumption is almost certainly going to be a factor. Bluetooth 5.2 is sometimes referred to as Bluetooth LE, which stands for Low Energy; we've all been there, realising we left our Bluetooth on and finding our phone battery is dead. 5.2 introduced a number of power-saving features, which are bound to be improved upon in future versions of the technology.

Beyond LE functions, we can likely also expect improvements to the maximum range and data rate of Bluetooth devices. Bluetooth 5 included functionality that allowed for boosted connection speeds at the cost of range, or a massively improved range (up to four times the standard radius) with a slower data rate. The sixth iteration is expected by speculators to develop this further, with the possibility of Bluetooth-powered one-to-many broadcasts over much longer distances.

Heads up, DisplayPort

DisplayPort 2.0 is another standard we can expect to see more of soon, with the alt-mode bundled in some cases with USB4 as we mentioned earlier. The standard was finalised in 2019 and represents the first major update to the DP connection standard since March 2016 (the release of DP 1.4).

Normal DisplayPort connectors will remain prevalent for a while, so it's unlikely that you'll need to urgently make any changes to your machines to accommodate the new standard. DP 2.0 offers greater flexibility than any previous version, with support for resolutions above 8K and improved HDR options. Standard DP 2.0 ports will be able to support a blinding 16K resolution at 60Hz, or up to three 8K displays at the same refresh rate.

Is this of interest to the average consumer? Right now, absolutely not. 16K displays are currently huge (far too big for a desktop setup) and only available to corporations via special orders. Sony offers an 18ft tall model, but it will set you back a

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Wi-Fi 7 will require new hardware, but isn't due to be finalised until at least 2024

few million bucks. Even the prospect of multiple 8K screens feels outlandish to us; it's not a standard that is representative of the common man's hardware arrangement, so DP 2.0 is reaching for the stars and leaving most of us behind.

Still, as display technology has been refined we've witnessed a steady shift upwards to higher resolutions as the default option. 1080p is currently the most popular resolution for PC gamers, but it hasn't held that crown for that long; plenty of people still play at 720p, while virtually every game has proper support for resolutions up to 4K now. 8K screens could well be the norm within ten years.

We'll need the current GPU crisis to settle down before the public can start to reap the benefits of higher resolutions.

Wi-Fi, on the other hand, is almost guaranteed to continue evolving. Specified as the IEEE 802.11 standard, a subset of IEEE 802, WLAN standards are diverse in purpose and functionality. Most 802.11 iterations are used for specific functions beyond traditional Wi-Fi as we might use it in our homes; for example, 802.11ah defines a wireless network running at sub-1GHz bands, ideal for wide-range, low-power uses such as outdoor Wi-Fi for traffic control.

The Wi-Fi we know and love is 802.11ac, or 802.11ax for those with more recent hardware. The 'ax' iteration is more commonly known as 'Wi-Fi 6' and represents the current apex of consumer WLAN options, thanks to better range and superior performance in signal-dense environments.

The Wi-Fi we know and love is 802.11ac, or 802.11ax for more recent hardware. The 'ax' iteration is more commonly known as 'Wi-Fi 6'.

High definition

HDMI acts as a sister format of sorts to DisplayPort, found more commonly on TVs than computer monitors. Unlike DisplayPort, there isn't a new standard of HDMI incoming; the most recent version is HDMI 2.1, officially released in 2017. The space between HDMI versions is typically greater than DP iterations, and HDMI 2.1 is already capable of supporting up to 10K resolution at 120Hz.

It's entirely possible that homogenisation of display connectors could occur over the next few decades, though only if the wider industry is willing to play nicely. The USB-C connector is already commonplace and could represent a shared ground for data transfers and display support, although this would ultimately mean the eradication of HDMI as a display interface standard.

What other evolving standards might we see in the future? The only key ground we haven't covered here is internet connectivity; Ethernet and Wi-Fi. The IEEE 802 family of standards (maintained by the Institute of Electrical and Electronics Engineers) has remained largely unchanged for years, presiding over LAN and PAN connections, amongst others. Physical cables for Ethernet connections have been improved over time, but the classic Ethernet port is unlikely to be leaving us soon.

Anticipating Wi-Fi 7 is a tricky business. Wi-Fi 6E was only announced a few months ago, offering 6GHz band operation compared to Wi-Fi 6's 2.4GHz and 5GHz options. There are a few different IEEE 802.11 standards currently in development, but the pertinent one is 802.11be. Also referred to as EHT (Extremely High Throughput), this standard will focus primarily on building upon the 802.11ax format with massively superior maximum speeds and improved signal stability.

Projections put the potential maximum throughput of 802.11be at a seriously nippy 30Gbps, triple that of Wi-Fi 6. The most common expected use is video streaming, which has increased massively in recent years. Using Wi-Fi 7 will demand compatible hardware, so be ready to buy a new router and motherboard. However, the IEEE doesn't expect to finalise the standard until 2024 at the earliest, so we'd consider this a low priority right now.

The world of PC hardware and software never stops marching on. We've made some predictions here that might never ring true; for all we know, a new standard could arrive on the scene next week and disrupt the status quo. Will it be a new bus interface? A new type of graphical memory? A port for video output? We couldn't say, but we can't wait to find out what comes next. ■

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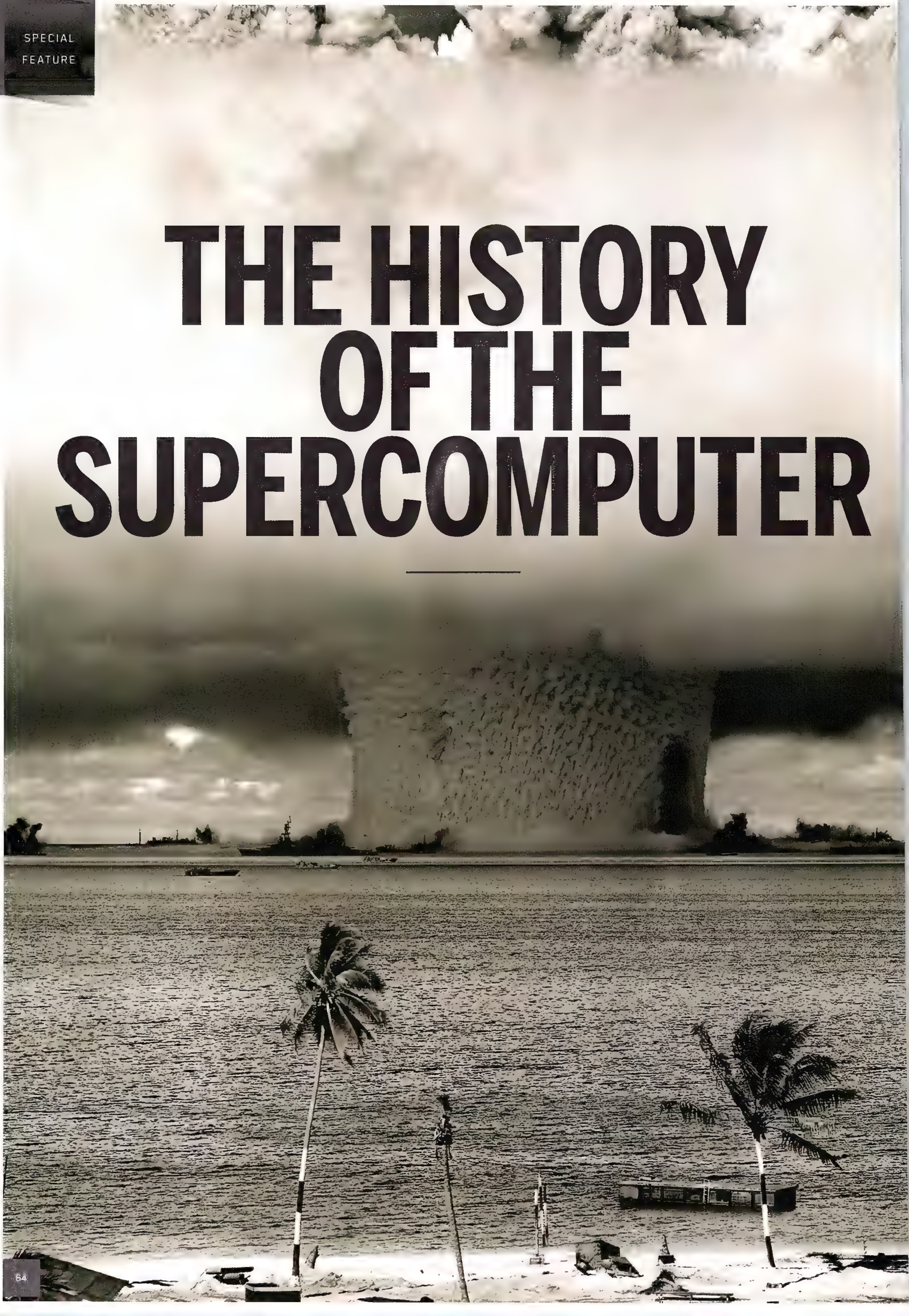
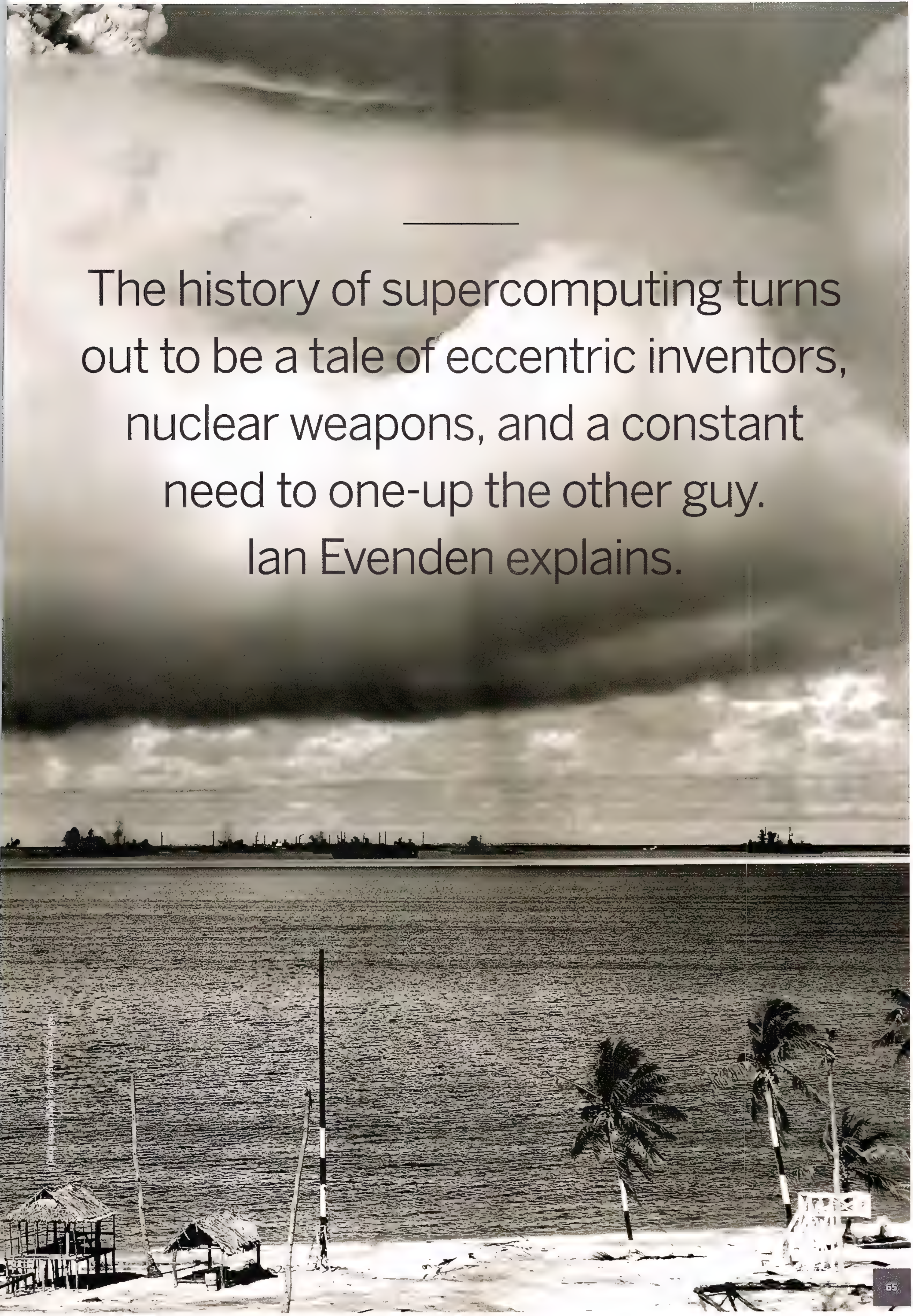
THE HISTORY OF THE SUPERCOMPUTER



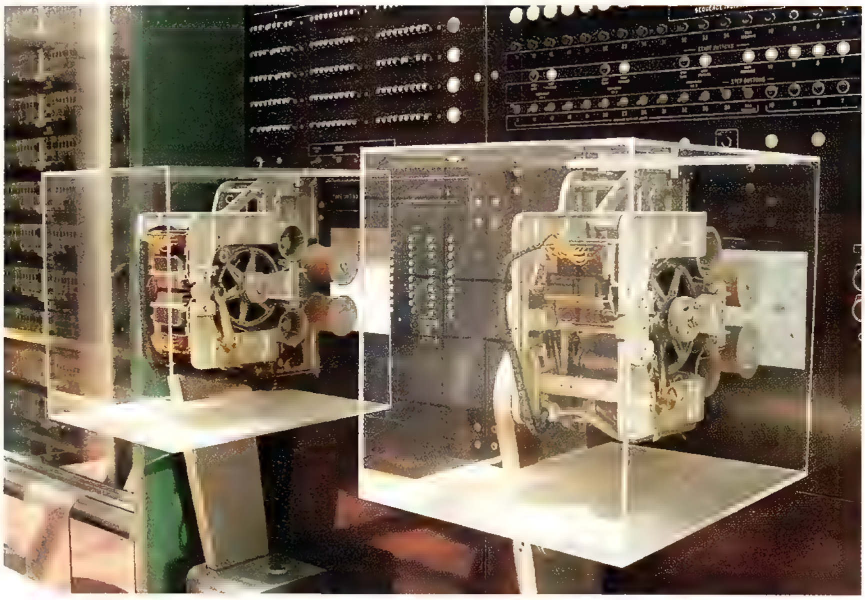


The history of supercomputing turns out to be a tale of eccentric inventors, nuclear weapons, and a constant need to one-up the other guy.

Ian Evenden explains.

CONTROL DATA
6600

The CDC 6600 from 1964 is often considered to be the first supercomputer.



Parts of the Harvard Mark I computer on display. Made by IBM, and proposed in 1937, John Von Neumann ran the first program on it in 1944 under the Manhattan Project.

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As anyone who's ever tried to work out a restaurant bill, including drinks, taxes, and tip, already knows, some math is difficult. Expand that by several orders of magnitude, and suddenly you're simulating the effects of a nuclear bomb, or protein folding, or calculating how many oil rigs to send up the Bering Strait before winter, and your needs go beyond mere computers. You need a supercomputer.

Established in the 1960s, supercomputers initially relied on vector processors before changing into the massively parallel machines we see today in the form of Japan's Fugaku (7,630,848 ARM processor cores producing 442 petaflops) and IBM's Summit (202,752 POWER9 CPU cores, plus 27,648 Nvidia Tesla V100 GPUs, producing 200 petaflops).

But how did we get to these monsters? And what are we using them for? The answers to that used to lie in physics, especially the explodey kind that can level a city. More recently, however, things like organic chemistry and climate modeling have taken precedence. The computers themselves are on a knife-edge, as the last drops of performance are squeezed out of traditional architectures and materials, and the search begins for new ones.

This, then, is the story of the supercomputer, and its contribution to human civilisation.

Define Super

What exactly is a supercomputer? Apple tried to market its G4 line as 'personal supercomputers' at around the turn of the millennium, but there's more to it than merely having multiple cores (although that certainly helps). Supercomputers are defined as being large, expensive, and with performance that hugely outstrips the mainstream.

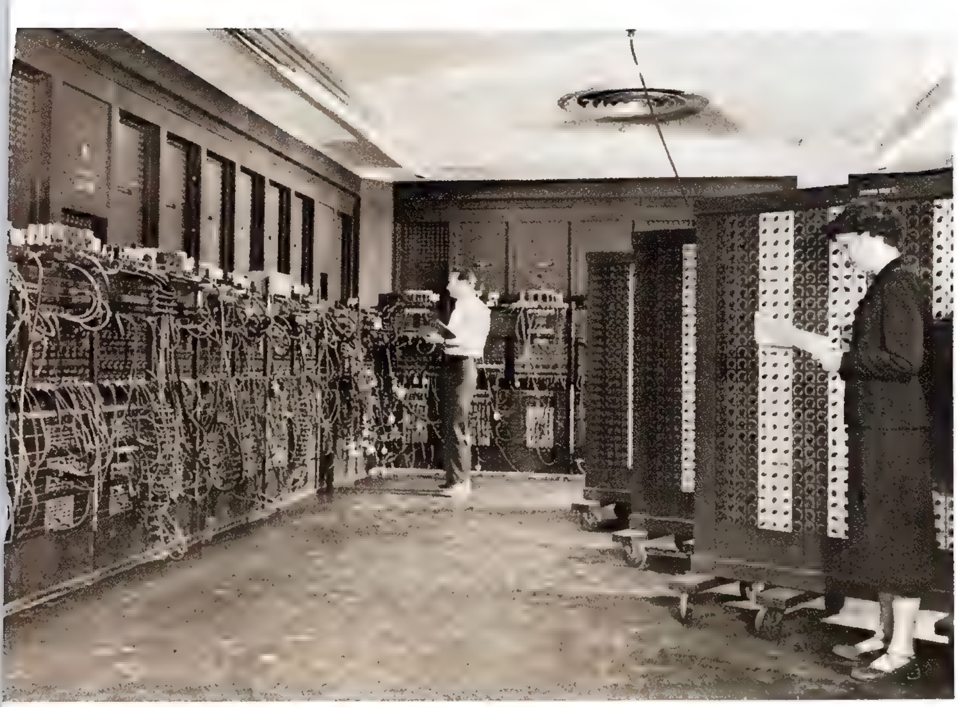
Apple's claim starts to make more sense when you compare the 20 gigaflops of performance reached by the hottest, most expensive, dual-processor, GPU-equipped G4 PowerMac to the four gigaflops of the average early-2000s Pentium 4. For context, Control Data's CDC Cyber supercomputer ran at 16 gigaflops in 1981, a figure reached by ARMv8 chips in today's high-end cell phones.

Before supercomputers there were simply computers, though some of them were definitely super. After World War II, many countries found ways to automate code-breaking and other intensive mathematical tasks, such as those involved in building nuclear weapons. So let's begin in 1945, and the ENIAC.

This programmable mass of valves and relays was designed to compute artillery trajectories, and it could do a calculation in 30 seconds that would take a human 20 hours. Its first test run, however, was commandeered by John von Neumann of the Los Alamos National Laboratory and consisted of calculations for producing a hydrogen bomb. ENIAC was programmed, and provided its output, using punch cards, and a single Los Alamos run used a million cards.

ENIAC was upgraded throughout its life, and when finally switched off in 1956 (having run continuously since 1947, pausing only to replace the tubes that blew approximately every two days) it contained 18,000 vacuum tubes, 7,200 crystal diodes, 1,500 relays, 70,000 resistors, 10,000 capacitors, and around half a million joints, all of them soldered by hand. It weighed 27 tons, and took up 1,800 sq ft, while sucking down 150kW of power. Its computational cycle took 200 microseconds to complete, during which time it could write a number to a register, read a number from a register, or add/subtract two numbers. Multiplication took the number of digits plus four cycles, so multiplying 10-digit numbers took 14 cycles, or 357 per second.

Early computers owed much to the design of the ENIAC and the British Colossus. Breaking enemy codes was still a high priority, as was finding ever



The ENIAC at the Ballistic Research Laboratory, Pennsylvania, circa 1950.

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more efficient ways to blow things up with both high explosives and pieces of uranium. It's around the early 1960s, though, that things such as processors and memory became recognisable. Take the UNIVAC LARC, or Livermore Advanced Research Computer, a dual-CPU design delivered in 1960 to help make nuclear bombs, and the fastest computer in the world until 1961. The LARC weighed 52 tons and could add two numbers in four microseconds.

Tech explosions

There was a burst of computer development in the early 1950s. IBM had been in the game since WWII, its Harvard Mark I electromechanical machine coming online in 1944, with one of its first programs, again run by Von Neumann to aid the Manhattan Project. In 1961, Big Blue would release the IBM 7030, known as Stretch, the first transistorised supercomputer and the fastest computer in the world until 1964 (a customised version of Stretch, known as Harvest, was used by the NSA for cryptanalysis from 1962 until 1976, when mechanical parts in its magnetic tape system wore out).

Von Neumann was behind another computer, sometimes named for him, at the Institute for Advanced Study in Princeton, which was in operation until 1958. This computer was the basis for a new generation, including the IBM 701, the ILLIAC I at the University of Illinois, and Los Alamos' alarmingly named MANIAC I, which became the first computer to beat a human at a chess-like game (on a 6x6 board with no bishops to suit the limitations of the machine).

The ILLIAC line would become highly influential, with ILLIAC II completed before Stretch and the open-source nature of its design leading to suspicions of 'borrowing'. Certainly, the two computers are early examples of a pipelined design, and feature heavy use of transistors instead of vacuum tubes. When faculty member Donald B Gillies programmed ILLIAC II to search for Mersenne prime numbers, it found three new ones.

The first massively parallel computer design was the ILLIAC 4 (the MkIII machine was designed to detect nuclear particles in bubble chambers, and was destroyed in a fire). Originally meant to have 256 floating-point units, and four CPUs, it could run at a billion operations a second, but due to budget constraints, only one CPU and 64 FPUs were completed in 1972. Even so, this quarter-computer still managed 50 Mflops, making it the fastest in the world. ILLIAC 4 was also the first networked supercomputer, being connected to the ARPAnet in 1975, a year before the Cray-1.

The genius of Cray

There's a name that shook the world of supercomputing. The whole story would be nothing without the influence of Seymour Cray, who joined Engineering Research Associates in 1951 to build code-breaking machines, but left in 1957 to co-found Control Data, and would later found Cray Research, Inc (now part of HP) in 1972. Cray was gifted, some might say eccentric (he dug a tunnel under his home, and attributed his successes to the advice of 'elves' who visited him there), and was given to spending hours in deep concentration to

WHAT HAPPENS TO DEAD SUPERCOMPUTERS?

Judging by the speed at which old supercomputers become obsolete (their average life expectancy is three years before an upgrade), and new champions rise to the top of the speed charts, you might expect there to be a boneyard in the Nevada desert, such as the 309th Aerospace Maintenance and Regeneration Group that mothballs old military equipment.

Alas, not. Old supercomputers don't just die, they get well and truly taken apart. The ILLIAC II, for example, was disassembled roughly a decade after its construction and many faculty members took components home to keep. Donald B Gillies himself kept 12 modules, donating them back to the University of Illinois Computer Science department in 2006.

It's not unheard of for piles of Xeons to appear on eBay following the dissolution of a supercomputer or datacentre, but more regularly these days the boards are sent for recycling. "There's a lot of gold and valuable metals in there," says Levesque. "And there are people who recycle these old machines."

Sexton's experience is more brutal. "They typically get crushed," he says. "In some of our contracts, we have a requirement to crush the parts after they're done, because customers don't want people going in and figuring out what they've been doing by reading back bits and bytes in memory."

With new systems meaning more compute for the same power and the same price, there's often no need to retain old systems, keeping one around and trying to restart it is just not worth it. Typically, hardware is disassembled and the remaining pieces are broken up and crushed. "There's a lot of gold, silver, and rare earth minerals in there, and there are companies that specialise in retrieving them," says Sexton.

Deep Blue was broken up with undue haste by IBM following its victory over Kasparov, and the story of the British government's destruction of Colossus, broken into pieces no larger than a man's fist and then kept secret for decades, reminds us that these huge, complex objects have a limited useful life.

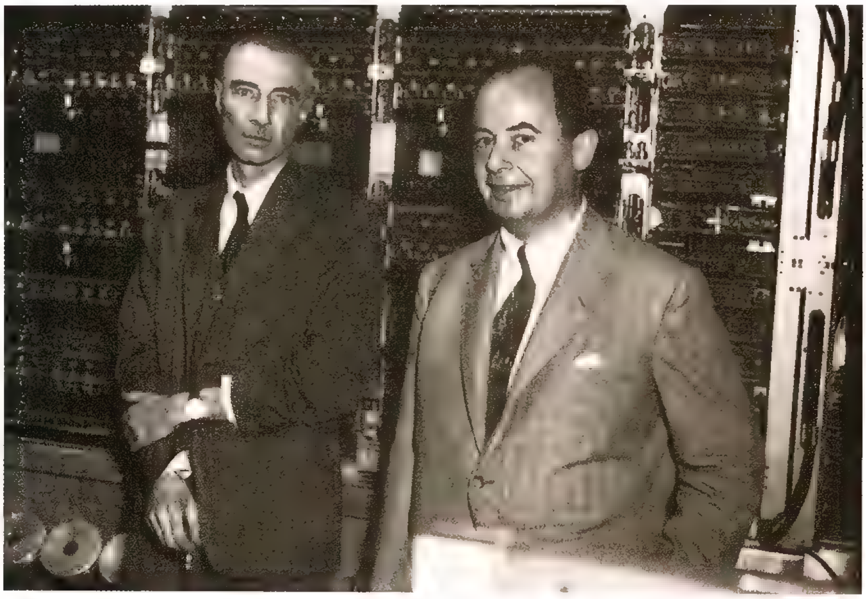
solve a problem. The reason early Cray machines are circular or C-shaped, for example, is so that every electrical interconnect can be the same length, so an electrical signal always takes the same amount of time to travel down each one.

In his book *The Supermen: Seymour Cray and the Technical Wizards Behind the Supercomputer*, author Charles J Murray relates this anecdote: “After a rare speech at the National Center for Atmospheric Research in Boulder, Colorado, in 1976, programmers in the audience had suddenly fallen silent when Cray offered to answer questions. He stood there for several minutes, waiting for their queries, but none came. When he left, the head of NCAR’s computing division chided the programmers: ‘Why didn’t someone raise a hand?’ After a few moments, one programmer replied, ‘How do you talk to God?’”

John Levesque, the Director of Cray’s Supercomputer Center of Excellence based at Los Alamos National Laboratory (home of the Manhattan Project and much US nuclear research since), remembers him: “He was very shy. It was extremely difficult to get him to give a talk. But when he did, it was outstanding. When I met him, all I did was shake his hand. He didn’t say anything.”

Levesque has worked on all the greats of early supercomputing and remains in the sector today. He began his career working on the ILLIAC 4: “The UK had a machine called the DAP [International Computers Limited’s Distributed Array Processor, the first commercially available parallel computer, delivered to its first customer in 1979] at the same time as the ILLIAC, and similar to it, but it didn’t have the support that the ILLIAC did. I know there are a lot of people who felt it was a complete failure, because it never went into production, and they only really developed a quarter of the machine.”

This wasn’t Levesque’s first brush with supercomputers, however. “I started working at Sandia National Laboratories in 1968. And I was working for the Underground Physics Department, and then I went to work at the Air Force weapons lab in Albuquerque for three years. Then I worked for a government contractor in 1972 in southern California called R&D Associates, and while I was there, I got a contract from DARPA [Defense Advanced Research Projects Agency, the branch of the DoD interested in new materials and ideas] to monitor ILLIAC 4 code development efforts.



Fathers of the atomic bomb: Robert Oppenheimer (left) and John von Neumann at the October 1952 dedication of the computer built for the Institute for Advanced Study.

John Levesque, head of Cray’s Supercomputer Center at Los Alamos National Laboratory, the home of US nuclear research.

“In 1976, Cray gave a computer to Los Alamos – it was serial number one – with the intent of convincing them that the machine would be extremely good for their applications. So because of the experience that my team had on the ILLIAC 4, and back to this point we probably had a team of five or six people, Los Alamos hired us to port and optimise their principal application to that Cray and so in 1977, we started working on that. We had a cross-compiler but, initially, there was no vectorising compiler, we were using what’s known as Cray vector primitives to load registers, perform operations, and store results. When Cray came out with a vectorising compiler, we wrote Fortran do-loops that could be optimised and used vector instructions on the Cray-1.”

“Los Alamos was primarily using CDC 7600s [from Control Data] which were also designed by Seymour Cray”, Levesque says. Peaking at 36 Mflops, the 7600 had a clock cycle of 27.5ns, for a speed of 36.4MHz on its strange 60-bit processor, and its base configuration sold for US$5 million in 1967. It wasn’t Cray’s first successful design, the Control Data 6000 series had outperformed IBM’s Stretch by a factor of three, and the 6600 was the fastest computer in the world from 1964 to 1969, when it lost the crown to the 7600.

The last of his Control Data designs was the 8600, essentially four 7600s welded together running at a faster cycle speed of 8ns; it was never released, and problems with its design and budget prompted Cray to leave the company in 1972.

He didn’t go far, setting up Cray Research in the same Wisconsin town as Control Data. The Cray-1, announced in 1975, was 5.5 tons of C-shaped genius running at 80MHz, with a cycle speed of 12.5ns on the faster, inside edge of the C (where interconnects could be shorter), it was slower on paper than the brute-force power of the 8600 but made up for it with cunning design, full 64-bit processing and limited parallelism for a peak output of 160 Mflops. The National Center for Atmospheric Research (NCAR) estimates it was 4.5 times faster than the 7600.

Levesque says Cray ‘gave’ the machine to Los Alamos, but there was a bidding war between the New Mexico lab and its rival, the Lawrence Livermore National Laboratory at the University of California, Berkeley. Los Alamos won and received the machine for a six-month trial. NCAR got one in 1977 (which it used until 1989), the NSA had one for code-breaking, possibly even before Los Alamos – a machine with serial number zero ended up in the British Atomic Weapons Establishment. In total, 80 Cray-1 machines were sold, for up to US$8 million each.

Vector processing

The key to the Cray-1’s success was its combination of all-round high performance with vector processing. Traditional scientific code was written as loops in Fortran, where the operands (the objects of a mathematical operation) were processed one at a time. Vector processing opened up the abilities of parallel computers by

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The Cray-1 supercomputer on display at the Computer Museum of America, Roswell, Georgia.

Boards from the ILLIAC 4 computer, state of the art in 1966.

carrying out the same operation on multiple pairs of operands at once, making it much more efficient. The trick was to convert the Fortran loops to vectors, which could be done automatically.

"The whole idea is that the user is writing in Fortran," says Levesque. "And so the compiler has to identify where it can use a ray operation. And the logical place is in a Fortran do-loop. The compiler has to determine if all of the operations are independent of one another. The main thing is that each add, or multiply, or multiply add, needs to be able to be done for the full extent of the do-loop. So the compiler determines that it can do that, and it generates vector instructions. There are things like NCAR's code, which had ambiguous subscripts and was extremely difficult to vectorise because of the way they wrote their loops. Cray told them, 'You have to rewrite your loops'. And NCAR said, 'We don't have enough manpower to rewrite our code'. And so, Cray came up with the very first compiler directive, which is a common line to any other compiler. It was DIR $ I V E P, and it stood for 'ignore vector dependencies'. Once this directive was placed in front of the loops of compiler-generated vector code, it ran fast. NCAR bought a Cray."

"Then, since we had experience on the Cray, we got numerous contracts to help people with moving their code to the Cray. We struck oil in the early '80s. At that time, there was a company by the name of ARCO that had been bought by BP. And there was a fella who gave a talk at a conference who said that his

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FLOPS

Computer power is measured in Floating Point Operations Per Second or flops. This number is used to compare different systems, with higher numbers meaning more power. PCs used to be given additional floating point units to help them with complicated calculations – we called them math co-processors, such as Intel's 80387 – but everything since the 486DX has had it bundled into the CPU (the co-processor for the 486SX, known as the i487SX, was a full-blown 486DX, and took over all processor functions as long as you left the original chip in place).

A floating-point number is simply one with a decimal point. That point, however, isn't fixed. Floating-point math trades range for precision (you'll sometimes see floating-point math qualified as '32-bit precision') and keeps a set number of significant digits from the numbers being juggled, then scales them by an exponent when finished to return them to their original length. This way, the large and the small can be represented by an integer of the same length, scaled by different exponents.

Konrad Zuse's Z1 mechanical computer from 1938 used 24-bit floating-point arithmetic and, until it was standardized in 1985, IBM, Cray, and other manufacturers all had their own floating-point formats, with IBM's being hexadecimal. As computers have become more powerful, the number of flops has been counted in the same way as bytes, from mega, giga, tera, peta, up to exa.

As all PCs are different, the current-gen consoles can provide a fixed point for comparison. The PlayStation 5 claims a combined figure of 10.3 teraflops, and the Xbox Series X 12.1 teraflops. Intel's first teraflop CPU was the Core i9-7980XE Extreme Edition with 18 cores from 2017, while the RTX 2080Ti GPU puts out 13.4 teraflops, a figure more than doubled by the RTX 3080Ti.

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i487™SX™
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The i487SX from Intel was rather more than just a math co-processor.

solution technique could not be vectorised. And so I got the code, vectorised it, and showed him, and ARCO ended up giving us a contract to port all of their reservoir simulators to the Cray.

It was kinda interesting because one time, the guy called me up and said, 'It's very important that you have this one code running fast'. And I asked why, and he said, 'Oh, we have to figure out how many oil drilling rigs to move up through the Bering Strait before it freezes over'. And we were successful. We even gave Cray training courses on the Cray."

Cooling components

The Cray-1 generated a lot of heat, so its cooling system was almost as lovingly designed as its integrated circuits. Circuit boards were placed back to back, with a sheet of copper in between. This spread heat to its edges, where it met stainless steel pipes containing liquid Freon, which carried the heat away to a cooling system mounted under the C-shaped main unit.

There were two updated versions of the Cray-1, the 1S, and 1M. These had larger memories, faster cycle times, the addition of MOS RAM and even solid-state storage. The Cray itself was supervised by a second computer, Data General Supernova or Eclipse models, which fed them their operating systems (Cray OS at first, then later a version of UNIX) at boot time and could act as a front-end – these changed through the years as well. Further Cray machines, developed by a different team under designer Steve Chen ("Outgoing and personable," according to Levesque), were released, each taking their turn as the fastest machine in the world, but it wasn't until the Cray-2 in 1985 that Cray himself returned to the top.

The first Cray design with multiple CPUs, four custom vector processors, the Cray-2 used novel 3D wiring techniques and a 'waterfall' cooler that's practically a work of art, but the new design had trouble beating 1982's Cray X-MP, developed from the Cray-1, and its successor the Y-MP. Sales were poor. The Cray-3, meant to be 12 times as powerful as the Cray-2, saw Seymour Cray and his company part ways once again, with Cray research continuing to work on the Cray C90 (a development of Y-MP tech that ran at 244MHz/4.1ns in 1991) and a spin-off, the Cray Computer Company, taking the Cray-3 tech and its single customer, the Lawrence Livermore Laboratory, with it. The laboratory would later cancel its order. Cray lent the sole Cray-3 built to NCAR as a demonstrator, but bankruptcy followed.

The Cray-2's internal wiring. And you thought your PC cables were a mess!

Left: Jim Sexton, an IBM Fellow and Director of Data Centric Systems.

Right: Seymour Cray, oddly looking like a cardboard cutout, with his Cray-1 computer.

This didn't stop Cray, whose Cray-4 scaled from four to 64 processors each running at 1GHz. A 16-processor system came with 8GB of memory, provided 32 Gflops, and cost US$11 million. Nobody was buying. The company stopped work in 1994, and Cray died following a car crash in 1996, aged 71. "It seems impossible to exaggerate the effect he had on the industry," said Joel Birnham, former CTO of Hewlett Packard, in tribute to Cray. "Many of the things that high-performance computers now do routinely were at the farthest edge of credibility when Seymour envisioned them."

His company would pass through a number of hands, including those of Silicon Graphics, Sun Microsystems, and Tera (which renamed itself Cray, Inc after the acquisition). Hewlett Packard Enterprise (HPE) acquired the company for US$1.3 billion in 2019, and today is building the LUMI supercomputer in Finland with a theoretical maximum performance of 550 petaflops, slotting into the top five fastest computers in the world.

One horse race?

While Cray was dominating, others hadn't been sitting around. MIT's Connection Machine, the result of work into alternative computer architectures that strayed from the orthodoxy put together by Von Neumann, started with 1985's CM-1 which had up to 65,536 individual processors, each extremely simple, processing one bit at a time, and a striking visual design for its casing that led to many programs being written just to blink its many LEDs. The CM range ended up, in the form of the CM-5, on top of the world computer speed rankings in 1993, with a 1,024-processor machine putting out 131.0 Gflops. One even appears in the Jurassic Park movie (though it's a Cray in the novel). Also topping the rankings in 1993 was Intel, cramming up to 4,000 i860 RISC processors into Paragon for up to 143.4 Gflops. Fujitsu's Numerical Wind Tunnel supercomputer used 166 vector processors to gain the top spot in 1994 with a peak

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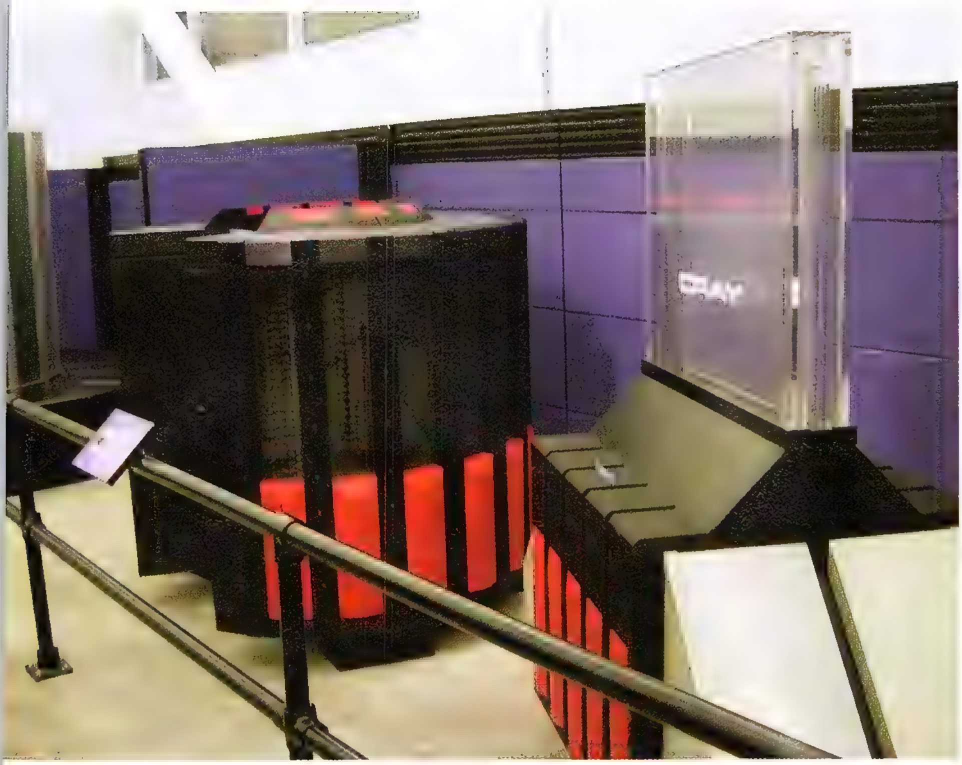


A Cray-2 (left) and its cooling system (right) on display at the computer History Museum

A Cray-2 logic module, showing the tight packing of components

speed of 170 Gflops.

IBM, in particular, had been releasing mainframes and minicomputers all through the 1950s to the '80s, as well as its PC line from the 1981 launch of the 5150 through the XT, AT, and more. A lot of what are thought of as its brands are actually made by Lenovo, coincidentally also the maker of 184 of the top 500 supercomputers, the company to which IBM sold its PC business in 2005. Mainframes, being suited for bulk data processing, are not the same as supercomputers, which tend to concentrate on one extremely complex task at a time.

Blue Gene, and its predecessor the Scalable POWERparallel (SP) series, changed all that in the 1990s. An example of cluster computing, computers that work together so closely they can be considered a single unit, they mark the emergence of IBM's Power architecture (known to Mac owners as PowerPC G3, G4, and G5, beloved of Xbox 360 and Nintendo Wii gamers, and also trundling about on Mars in the Curiosity and Perseverance rovers).

ASCI

Nuclear weapons rear their head too at around this time, with the creation of the Advanced Simulation and Computing Initiative (ASCI), a supercomputing program to extend the lifetime of the US's aging stockpile of nukes by simulating the way a nuclear weapon will react under different conditions. Essentially, if we leave these things in the cupboard for 50 more years, will they still go bang if we want them to?

"A big change in computing came around in the early 1990s, and that was due to the Nuclear Test Ban Treaty," says Jim Sexton, an IBM Fellow and Director of Data Centric Systems at the company. "In the 90s, it became clear that computing would allow them to manage the stockpile of nuclear weapons with simulations rather than having to go and actually explode the bombs. When you

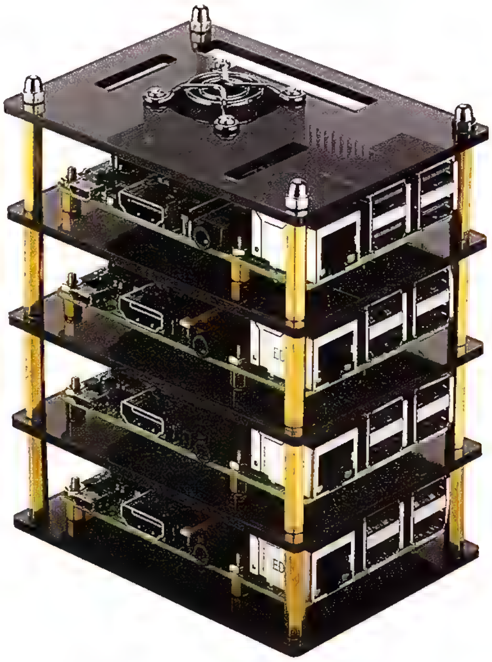
BEOWULF CLUSTERS

You don't need a supercomputer to achieve high-performance computing. The Beowulf Cluster, from an original idea by Thomas Sterling and Donald Becker at NASA in 1994, is a group of normally, but not necessarily, identical PCs networked together and running software that shares processing between them.

Most run Linux, or BSD distributions tailored to the task, such as ClusterKnoppix, but there's nothing specifically that marks a cluster out as a Beowulf, that's just the name of the original grouping.

Since 2017, every system on the Top 500 list of supercomputers has used Beowulf methods to some degree, aided by the fact that such a cluster is almost infinitely expandable, limited only by network overheads. To this end, the simple Ethernet that joins up a Beowulf has been replaced by optical connections in the fastest supercomputers, with Nvidia's NVLink providing a bridge between its GPUs.

The idea is popular with Raspberry Pi owners, as the inexpensive boards can scale through a simple network switch and the Message Passing Interface software. Such a cluster can make a nice web server, or for learning Docker or Kubernetes, or as a fast file server for a home office setup.



A Raspberry Pi 4 cluster case by MakerFun, with four Pis installed.

© MakerFun, Wikipedia

have a mission of that order, and that complexity, people get very focused on developing computing systems to support your work. Up until then, the way people had been designing computers was just playing around, trying different things.

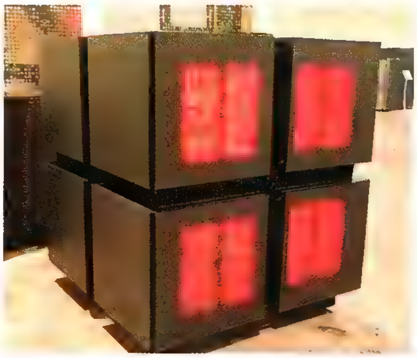
"ASCI kicked off," Sexton adds, "and has had a sequence of supercomputers developed ever since. There were a number of players in the early days: IBM was providing some of the computers, Cray was providing some of the computers, a couple of other names too, and what quickly happened is that there was an insatiable demand for computing power. And there was a limit on how much power you could deliver to a laboratory to run a computer. We're up to 40 or 50 megawatts today, the biggest ones in the world are our own national labs in the US."

This hunger for power has led to a new consideration in supercomputer design – efficiency. Born out of a five-year plan to build a massively parallel computer to address protein folding and other biomolecular phenomena, the project had a secondary aim of exploring new ideas in parallel computing architecture, the problem with supercomputers being that new ones are hard to simulate on existing hardware. In the early 2000s, there was a bit of a plateau in computer speeds. NEC's Earth Simulator had been at the top of the rankings from March 2002 until November 2004, its 35.86 teraflops pushing out ASCI White's 7.226 teraflops that had been top for a year previously.

"Blue Gene was designed to be power-efficient," says Sexton of a machine that forced its way to the top with 70.72 teraflops before losing the title to another IBM machine, Roadrunner at Los Alamos, in June 2008. "We were building systems with 100,000 CPU cores in the early 2000s, and that was unheard of at the time, to be able to get that many computer cores to work coherently together.

"And then towards the end of that time, what emerged was GPU acceleration. It turns out that GPUs are actually quite power-efficient, and a significant strain on the design of computers is your ability to manage power. A lot of systems design is about how to get more computing power into a system, but staying within a given power. The Blue Gene architecture used incredibly simple, lightweight, low power cores, but by the time we got to around 2014 or 2015, it became clear we would not be able to continue to improve performance with that technology."

The Cray XC-40, also known as Hazel Hen, at the High Performance Computing Center of the University of Stuttgart. It began operation in 2015.



The CM-1 at the Computer Museum of America, with its plethora of red LEDs.

summit
OAK RIDGE
IBM

ing a Trusted Future
FU

Above: One node of the Fugaku supercomputer.

Left: Part of IBM's Summit supercomputer.

Modern day

Trading power consumption for speed, Blue Gene/L (originally 'Blue Light') contains two PowerPC 440 cores running at 700MHz with floating-point accelerators in each node, with 1,024 nodes in each 19in rack, up to a minimum of 64 racks (65,536 nodes). A lightweight Linux OS further pares back the overhead. Blue Gene/P further developed this, with its PowerPC 450 cores running at 850MHz and with twice the chip-to-chip bandwidth of the L model, but with four cores per node and 4,096 cores per rack.

Blue Gene/Q dispenses with PowerPC, using instead IBM's A2 open-source architecture. This means 18-core chips with four threads per core and a speed of 1.6GHz. Each rack contains 1,024 compute nodes, 16,384 user cores (16 are available, the 17th runs the OS, and the 18th is either a redundant spare or there to increase manufacturing yields) and 16 TB RAM.

Blue Gene is also notable for sprouting Deep Blue, the computer that beat Grandmaster Gary Kasparov at chess in 1996. With its roots reaching back to 1985, and earlier attempts to teach a computer to play chess, Deep Blue is more of an ASIC (Application Specific Integrated Circuit) as it uses specialised chips alongside IBM Power2 processors to brute-force solutions to chess problems rather than displaying modern artificial intelligence.

"We are at the limit of what it is physically possible to program and manage, so then we did a switch to work with Nvidia and built the fastest computers in the US National Labs: Summit and Sierra. They have tightly coupled CPUs and GPUs, and are at 200 petaflops today."

Planned machines will produce more than an exaflop of computing power, comparable to that put out by Folding@home during the great push to discover vulnerabilities in the protein-coding of the SARS-COV2 virus. "We're at a disruptive time in computing," says Sexton. "We're running out of technology, and yet the demands of computing continue to grow. The ability for AI to do things, to get you more access to knowledge, it requires more

© Wikimedia/Judson McCranie/Carlos Jones/Raysonho

Blue Gene/P at the Argonne National Laboratory, in Lemont, Illinois.

and more compute. If you think of a self-driving car, something a lot of people talk about, getting a computer to drive a car is actually quite a lot, so you're seeing huge amounts of concrete everywhere.

"The history from 1995 to today and into the next few years has been driven primarily by the mission activities that have supported nuclear weapons," he continues, "and all the science that goes around understanding materials, understanding climate, understanding weather, understanding biological systems, so we're now at the point where you can actually do serious simulation. Every five years, we were seeing a tenfold increase in peak performance. We're now at an exaflop, so we've gone three orders of magnitude, in terms of performance, in 15 years. It's absolutely amazing that that's possible, but hard to see how it's going to continue.

"On the other hand, the computing that we do is changing drastically now. It's less and less about trying to focus on understanding basic physics and more and more about AI, and data analytics. It's been a very interesting ride, but I don't think the future of computing is going to be around nuclear weapons. I think we've reached the limits of traditional computing, but we have all these new capabilities coming too."

Fugaku king

This may explain how Fugaku, a system made of an ungodly number of ARM-based CPU cores and no GPUs, was able to overtake Summit in June 2020 to take the top spot on the big list of really fast computers. Competition between nations for the prestige of hosting the world's greatest supercomputer may still be a factor, but we may have to look elsewhere, such as distributed computing systems, to catch the really big numbers in future.

Or we could change the way we design our computers. A resurgence in analog computing, maybe? "We as humans, we don't really work as precise ones and zeros," says Sexton. "Our brain computes analog, and it does a pretty good job. When you look at a lot of the domain out there, do I need a computer of ones and zeroes to drive a car? Would it be better to go to an interesting, analog, future?

"An analog computer deals with a range of values," he continues. "It doesn't give you a precise binary value for something. And then there's a different way of calculating, and you do that by having different materials analysing the different programs or occasional model. In-memory computing is another one. More and more challenging computing is moving away from the old Von Neumann model, where you have your data in memory and move it to a computer to compute. We're looking for ways around that because a significant amount of the power in the computer is going into moving data."

Whatever happens, as quantum computers approach from left-field or new materials other than silicon become more common in microchip manufacture, we may never leave the age of the supercomputer behind. They may just fade into the background of our society, giant machines that help when great scientific problems need solving and spend the rest of their time predicting the weather. But that's another story. ■

© Wikipedia, Argonne National Laboratory/ wikipedia

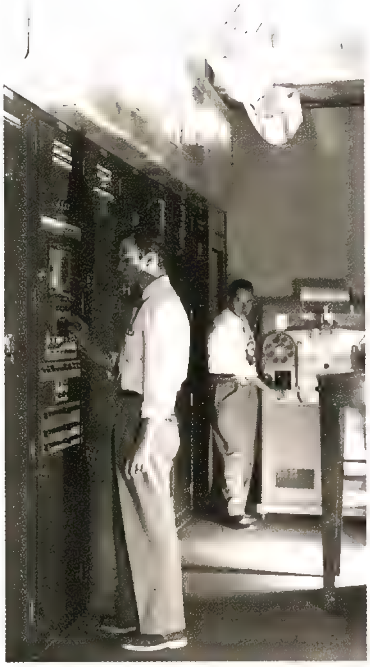
THE VON NEUMANN MODEL

The Von Neumann Model is a computer architecture, first proposed in 1945, that makes up the majority of computers in the world today. It is named after John von Neumann, a Hungarian child prodigy who came to the US in 1937 and ended up working on the Manhattan Project.

In 1945, he wrote a document called the First Draft of a Report on the EDVAC, in which he described a "high-speed automatic digital computing system". He divided it into six major parts: a central arithmetic part, a central control part, memory, input, output, and (slow) external memory.

The word 'bit' had not yet been coined, but Von Neumann detailed a system using 27 binary digits to represent numbers up to eight decimal places. On top of this, he added ways to distinguish numbers from one another, reaching 32.

The EDVAC was the successor to ENIAC, proposed in 1944 and delivered in 1949. Its importance comes in its ability to store programs in the same memory as the data to be processed, something that would influence the design of almost every computer after it. A computer with separate program and data memories is said to follow Harvard Architecture.



The EDVAC installed in the Ballistic Research Laboratory at Aberdeen Proving Ground, Maryland.

System news

As we hit the big 500, Mark Williams reminisces on the past and investigates the future with Intel.

MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

Having been introduced to PCs by my father as a youngster, I've been interested in all things PC and tech since the early '90s – if not even earlier. Anyone who grew up during that explosion in the popularity of the computer scene knows just how important technology magazines were back then, for knowing what was going on and for keeping up to date with the latest innovations and products.

With the internet barely being a thing and not easily to accessible for many, magazines – with their wealth of news, reviews, in-depth features and the all-important cover CD (and later DVDs to save on precious download quotas) – were monthly hits of gold that helped foster and nurture many into the IT field, where careers were born.

While today the landscape has changed, with the dominance of the internet and its ever-increasing flow of information, it's great to see *APC* still going strong and achieving such a huge milestone with its 500th issue.

For me, after growing up reading such magazines, now being able to write for a magazine in Australia – let alone the most famous one – is to give back to the community the enthusiasm for PCs and tech that was instilled in me in those early years. It's quite the privilege and honour.

For those unaware, the Australian tech magazine scene has many publications to thank over the years, including *Hyper*, *PC PowerPlay*, *Atomic*, *Tech Living*, *Australian Home Technology*, *PC & Tech Authority*, *T3*, and of course *APC*. While that's not an exhaustive list of Australian tech publications, it is the list of magazines that our editor Ben Mansill either conceived of and started from the ground up, or has spent many years editing. (*blatant editor fawning – but I'll allow it. Ed*).

With the printed word having to fight harder than ever to keep its place in an ever more digital world, you can rest assured that this enthusiastic seasoned stalwart of the Australian computing and tech reporting scene will continue to bring readers unique in-depth content that covers and is relevant to our local market.

Imagine what technology we'll be covering in another five or ten years, let alone another 41?

While today the landscape has changed with the dominance of the internet and its ever-increasing flow of information, it's great to see APC still going strong and achieving such a huge milestone with its 500th issue.

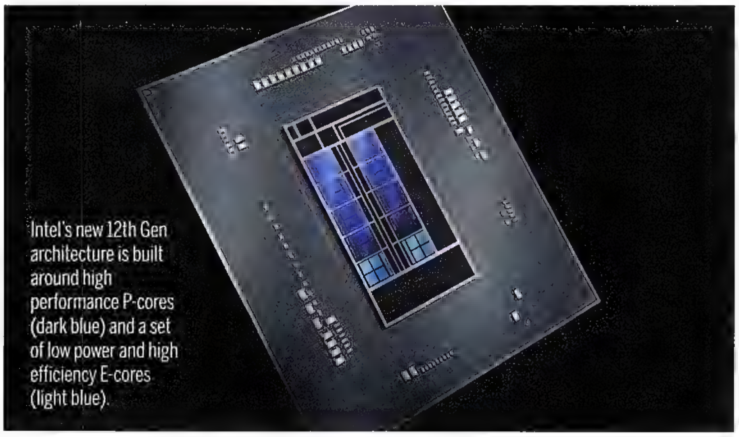
Intel on the rise

Speaking of the next five to ten years, in the ongoing core wars between Intel and AMD, we're now seeing what Intel has been planning all this time to properly strike back against AMD's Ryzen. Like AMD, which decided to change the game entirely with chiplets in order to beat Intel at its own game, it appears Intel has learned that lesson and is now changing the rules once again by designing its upcoming Alder Lake products with a big.LITTLE (**wikipedia.org/wiki/ARM_big.LITTLE**) inspired design popularised by ARM.

With four efficient Gracemont E-Cores taking up the same die space as a single higher-performance Golden Cove P-Core, Intel's 12th Generation processors are all looking to have eight E-Cores and anywhere from two to eight P-Cores, depending on the product.

Impressively an 8 E-core, 8 P-core 12900K processor benchmarked with CPU-Z showed single-threaded performance over 27 percent faster than AMD's full-fat-cored Ryzen 5950X, and a multicore score that appears to match it.

It seems Intel will have quite a formidable architecture on its hands, and with the P-Cores showing that much of an advantage in performance, AMD will be very concerned. Intel's 12th Generation will be the foundation of its battle strategy against AMD over the next decade. We can't wait to get our hands on it! ■



Intel's new 12th Gen architecture is built around high performance P-cores (dark blue) and a set of low power and high efficiency E-cores (light blue).

SHOP TALK

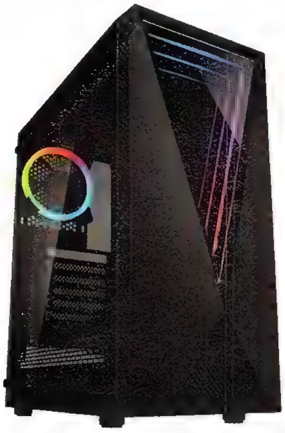
What does APC magazine mean to you? How have Australian IT/Computer magazines shaped you and your business over the years?

Jaimie, Leader Computers: "I have worked in the IT industry for 25 years now, and publications like yours were my primary means of keeping up with the trending products and emerging technologies for at least the first 15 years!

While the internet has changed our reliance on the printed word, *APC* magazine has managed to stay entertaining, informative and most importantly, relevant in its content and commentary. I still subscribe, albeit digitally these days, and love seeing what the crew have put together every publication. Keep up the good work and I look forward to your next 500!"

Market snapshot

A sampling of PC systems available this month.



$2,199 – tinyurl.com/APC500PCC

PC CASE GEAR VOID 1660 TI

If you're looking to dip your toes into playing some competitive eSport titles this is a nice place to start. By today's standards it's effectively priced and gives you a decent base to start from and upgrade parts later. The CPU is one of the most popular on sale, and for good reason, as it'll handle any game well at a great price. The GTX 1660 Ti is a solid performer at 1080p with the previously mentioned type of game titles and will offer a good experience even at 1440p with the right settings. The RAM is a perfect match in both capacity and speed, and while the SSD isn't the fastest, for the price it's acceptable.

Lastly, the case, while basic ,offers a ton of front IO and has an infinity mirror, which always wins points in the looks department.

CPU: AMD Ryzen 5 3600 **Cooler:** OEM **Motherboard:** MSI B450 Tomahawk Max II **Graphics:** MSI GeForce GTX 1660 Ti Armor OC 6GB **Memory:** 16GB Team T-Force Delta RGB 3200MHz CL16 DDR4 Black **Storage:** PNY CS900 2.5in SATA SSD 500GB, Seagate Barracuda 2TB HDD **Power Supply:** Kolink modular 600W **Case:** Kolink Void RGB

$2,899 – tinyurl.com/APC500PLE

PLE COMPUTERS AURORA

A white- and black-themed build with splashes of rainbow found on custom sleeved internal power cabling makes for an interesting but surprisingly beautiful system. With a very powerful CPU it's actually a little over the top if just gaming is your jam. It'll certainly help if high FPS gaming is what you're targeting but the GPU, while good for both higher FPS 1080p and regular 1440p, isn't exactly the best pairing and leaves this system a little lopsided. One of the *Gundam*-themed graphics cards would've been ideal with this system's theme! A missed trick by PLE. The RAM, SSD, power supply and motherboard are all well specced and the hard drive will do, though at 1TB it's a little small for this money. A great system for gamers that do some extra productivity on the side.

CPU: Intel Core i9 11900 **Cooler:** Corsair iCue H150i Elite Capellix AIO **Motherboard:** Gigabyte Z590 UD AC **Graphics:** Gigabyte GeForce RTX 3060 Ti Eagle LHR 8GB GDDR6 **Memory:** 16GB GelL DDR4 Super Luce RGB C16 3000MHz **Storage:** Samsung 980 500GB NVMe M.2 SSD, Seagate BarraCuda 1TB HDD **Power Supply:** eVGA GD Series 600W **Case:** Deepcool Macube 310 White

$3,599 – tinyurl.com/APC500MWV

MWAVE RESPAWN NINJA FURIOUS

Targeting the enthusiast crowd, this system would be welcome on anyone's desk, especially the tinkerers. Sporting an unlocked ten-core processor, matched with a 240mm water cooler and an 850W power supply, this system is begging for an overclock.

While not the latest 11th gen part, the extra two cores it offers over the latest 11900K will help this system rip through productivity tasks easily, aided by the roomy 32GB of RAM. The roomy SSD and hard drive housed in a high airflow case round out some very nice specifications that are good for 1440P and even 4K gaming depending on how it's done. A very capable and exciting system.

CPU: Intel Core i9 10850K **Cooler:** CoolerMaster MasterLiquid 240mm AIO **Motherboard:** Gigabyte Z590 Aorus Ultra **Graphics:** Gigabyte GeForce RTX 3070 Gaming OC 8GB **Memory:** 32GB T-Force Delta RGB DDR4 3600MHz **Storage:** Seagate FireCuda 510 1TB NVMe M.2 SSD, Seagate 2TB HDD **Power Supply:** Gigabyte Aorus AP850GM 850W **Case:** Cooler Master MasterBox TD500 ARGB

$7,399 – tinyurl.com/APC500JWC

JW COMPUTERS DOMINATOR 3090

The Dominator sets out to achieve exactly what its name implies. With the fastest desktop CPU and graphics card inside, this system won't pull any punches when it comes time to tackle any productivity task or game you can throw at it. Oodles of system and video RAM will make any video editor, 3D modeller, or AI enthusiast happy indeed. The triple slot graphics card and the liquid-cooled CPU offer ample cooling headroom and will aid greatly in pushing the humungous 1300W power supply hard when overclocking.

The glass front of the case isn't ideal for airflow. If you decide to start pushing the limits of this system, we recommend removing the glass panel to allow the case to breathe better. The only mark against this build is the SSD. At 1TB, and being the only drive, given how much data this system can chew through on productivity tasks it may feel small very quickly.

CPU: AMD Ryzen 9 5950X **Cooler:** Corsair H100i RGB AIO **Motherboard:** Gigabyte X570 Aorus Master **Graphics:** Gigabyte Aorus Master RTX3090 Gaming 24GB **Memory:** Corsair Vengeance Pro 32GB DDR4 3600MHz RGB **Storage:** 1TB Samsung 970 Evo Plus M.2 NVME SSD **Power Supply:** Coolermaster V1300 **Case:** Corsair iCUE 4000X ARGB ■

BLUEPRINTS

VALUE- AND PERFORMANCE-DRIVEN HYPOTHETICAL BUILDS

PC BUILDER

Budget

A perfect balance between price and peformance.

After some dicey CPU stock situations last month, we're pleased to report that our budget builds have returned to a (somewhat) more normal state. The Ryzen 3 3100 we promised last time is here, a little hard to find, but available for a reasonable $190. The 3100 brings us a tidy 8-thread processing solution, offering significantly boosted performance over the Ryzen 3 1200 we had to settle for last month. That third-gen Ryzen chip means we have access to PCIe 4.0 once again, so we splashed out and upgraded our motherboard for a further 40 dollars.

This MSI B550M Pro motherboard guarantees speedy transfers in the budget AMD machine; so naturally, we need a new M.2 SSD to run those speedy transfers. We opted for PNY's CS3040 PCIe 4.0 drive – not the fastest Gen4 M.2 SSD, but with half a terabyte of storage for $135, it's one of the best-value options.

Unfortunately, Intel motherboards seem to be having difficulties right now. The B460M boards we've recommended are either jacked up in price or unavailable, so we've had to settle for the more expensive – albeit more visually appealing – B460M Steel Legend from Asrock. The price of the Core i3-10100 has also climbed a little, but not so much as to provoke a CPU swap.

The Intel budget machine might not have PCIe 4.0, but still gets an SSD capacity bump courtesy of Crucial's P2 M.2 drive, a steal at $90.

Have our GPU prices dropped yet? Sadly, no… we'll be waiting some time for those graphics cards to return from the crypto wars. With scalpers abounding across the internet, stocks in Australia are still faring relatively better than in some other countries, so that's a small mercy we're grateful for.

AMD INGREDIENTS

PART		PRICE
CASE	Corsair 4000D Airflow	$130
PSU	500W EVGA BR 80+ Bronze	$90
M/BOARD	MSI B550M PRO AM4 NEW	$130
CPU	AMD Ryzen 3 3100 NEW	$190
GPU	AMD Radeon RX 6700 XT 12GB	$1,300
RAM	16GB (2x8GB) Crucial Ballistix @ 3200MHz	$120
SSD	500GB PNY CS3040 M.2 NVMe Gen4 SSD NEW	$135
HDD	1TB WD Blue 1TB 7200	$60
OS	Windows 10 Home 64-bit OEM	$60
PRICE		$2,215

INTEL INGREDIENTS

PART		PRICE
CASE	Corsair 4000D Airflow	$130
PSU	500W EVGA BR 80+ Bronze	$90
M/BOARD	Asrock B460M Steel Legend NEW	$140
CPU	Intel Core i3-10100	$200
GPU	Nvidia GeForce RTX 3060 12GB	$1,300
RAM	16GB (2x8GB) Crucial Ballistix @ 3200MHz NEW	$120
SSD	500GB Crucial P2 PCIe 3.0 M.2 SSD NEW	$90
HDD	1TB WD Blue 1TB 7200	$60
OS	Windows 10 Home 64-bit OEM	$60
PRICE		$2,190

PC BUILDER

Mid-range

A very much game-ready machine, ready for demanding regular work, too.

If you're after a solid midrange CPU, keep an eye on the Ryzen 5600X's price because snapping one up for around $430 is a great idea. The Core i7-11700K in our midrange Intel machine isn't quite as affordable, but unlike budget CPUs, these prices seem to be holding steady for now. Our two motherboards here remain the best-value pickings, so there wasn't much to tweak in the midrange builds.

Fractal Design's excellent Ion Gold PSUs are still great value so the AMD system hangs onto its power brick, but we've swapped out the power supply in the Intel build for a Corsair RM650M model this month. Last month's Intel build Enermax AIO CPU cooler is now almost impossible to find, so we're moving to the same extremely well-priced Cooler Master 240 as in the AMD build.

Both systems will, however, benefit from new RAM this month. Memory prices might be in constant flux, but we're taking those minor savings and bumping both midrange machines up to some carefully selected CL16 RAM. In the AMD build, that's the ever-reliable Crucial Ballistix memory (in sleek matte white), while the Intel build gets treated to Kingston's new FURY Renegade RGB kit. We say 'new'; Kingston and HyperX recently parted ways in RAM production, resulting in a swift rebrand of the FURY memory line. These new RGB DIMMs do look nice, though, with a black finish and a subtle lightstrip across the top.

Corsair's 500GB Force MP600 PCIe 4.0 drive has dipped down to a charming $134, joined by similar offerings from Gigabyte. The PNY CS3040 SSD seen last month in the AMD midrange build has now been switched over to the Corsair, and the same SSD is staying put in our Intel build. As we mentioned in the budget build notes, the 1TB WD Blue drives are starting to look like a permanent fixture in these builds.

AMD INGREDIENTS

PART		PRICE
CASE	Lian Li PC-011-Dynamic	$210
PSU	650W Fractal Design Ion Gold	$140
M/BOARD	Asus AM4 TUF Gaming X570-Plus WiFi	$330
CPU	AMD Ryzen 5 5600X	$430
COOLER	240mm Cooler Master Masterliquid ML240L RGB	$100
GPU	Nvidia GeForce RTX 3070 8GB	$2,000
RAM	16GB (2 x 8GB) Crucial Ballistix @ 3600MHz **NEW**	$140
SSD	500GB Corsair Force MP600 M.2 PCIe 4.0 **NEW**	$140
HDD	1TB WD Blue 1TB 7200	$60
OS	Windows 10 Home 64-bit OEM	$60
PRICE		$3,610

INTEL INGREDIENTS

PART		PRICE
CASE	Lian Li PC-011-Dynamic	$210
PSU	650W Corsair RM650M 80+ Gold **NEW**	$95
M/BOARD	Asrock Z590M PRO4	$230
CPU	Intel Core i7-11700K	$590
COOLER	240mm Cooler Master Masterliquid ML240L RGB **NEW**	$60
GPU	AMD Radeon RX 6800 XT 16GB	$2,000
RAM	16GB (2 x 8GB) Kingston FURY Renegade RGB @ 3600MHz **NEW**	$160
SSD	500GB Corsair Force MP600 M.2 PCIe 4.0	$140
HDD	1TB WD Blue 1TB 7200	$60
OS	Windows 10 Home 64-bit OEM	$60
PRICE		$3,605

PC BUILDER

Turbo

The maximum PC.

We found Western Digital's 3TB 5400RPM HDDs available widely at around $105 a drive, and doubling up on these proved cheaper than a single 6TB HDD at the same RPM. Yes, 7200RPM HDDs are faster, but these chunky drives are for secondary storage, and both our Turbo builds have a terabyte of super-speedy PCIe 4.0 SSD space anyway.

Speaking of which, the Samsung 980 Pro and the similarly fast 7000s from Gigabyte keep their place in each system system, for now. 1TB PCIe 4.0 SSDs offer a wide price range, but more expensive models don't necessarily offer higher speeds; check the reviews rather than take the manufacturers at their word.

Both our builds get new 4000MHz memory, as the previous G.Skill Ripjaws V RAM is no longer available at a discounted price. We kept things sleek and simple in both machines with the shiny new RGB lighting from the 2x16GB Trident Z Neo kit.

There was nothing else for us to reasonably tweak in our AMD Turbo PC this issue; Corsair's awesome 360mm Capellix cooler remains one of the best AIOs for powerful systems, and pricing on our other components here remained largely unchanged.

Our Intel machine has had some new additions. Fractal Design's Ion Gold PSUs aren't just good for mid-range builds; the 750W and 850W models are budget-friendly power supplies, considering their general build quality and a seven-year warranty. For $160, the 750W version is a shoo-in for a beefy build like this.

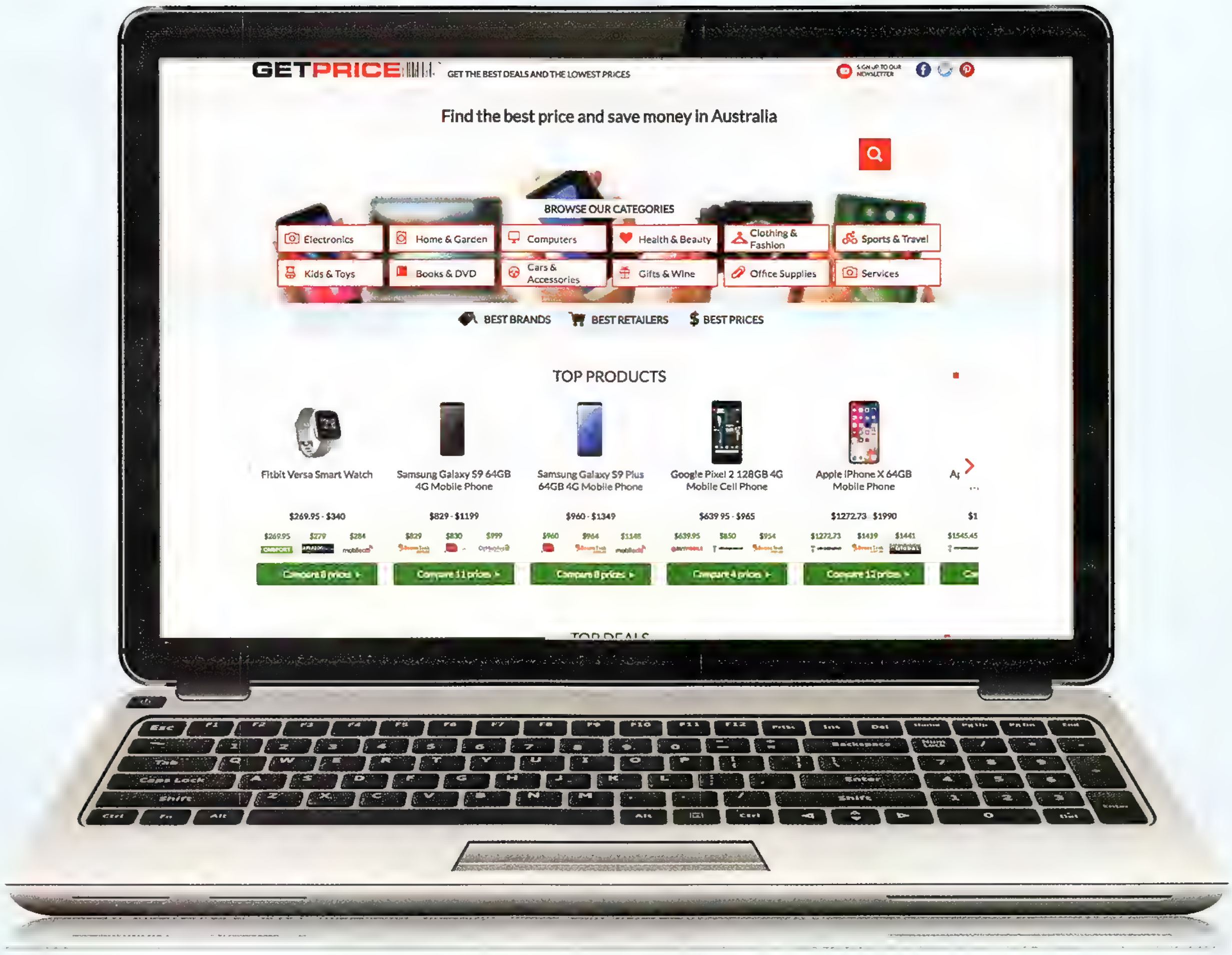
The Intel Turbo build also gets a new motherboard, matching its MSI MAG cooler with a MAG motherboard. That's the MSI MAG Z590 Tomahawk WiFi at $220. This has all the bells and whistles you need, from PCIe 4.0 support to built-in 802.11a/b/g/n/ac/ax wireless and memory overclocking headroom to support that speedy RAM. ■

AMD INGREDIENTS

PART		PRICE
CASE	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	750W Nzxt C750 80+ Gold	$140
M/BOARD	MSI MPG X570 Gaming Edge Wi-Fi	$260
CPU	AMD Ryzen 7 5800X	$630
COOLER	Corsair iCUE H150i ELITE CAPELLIX AIO 360mm	$260
GPU	AMD Radeon RX 6900 XT 16GB	$2,600
RAM	32GB (2 x 16GB) G.Skill Trident Z Neo @ 4000MHz NEW	$550
SSD	1TB Samsung 980 Pro M.2 PCIe 4.0	$250
HDD	2x 3TB WD Blue 5400 HDD NEW	$210
OS	Windows 10 Home 64-bit OEM	$60
PRICE		$5,180

INTEL INGREDIENTS

PART		PRICE
CASE	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	750W Fractal Design Ion Gold NEW	$160
M/BOARD	MSI MAG Z590 Tomahawk WiFi NEW	$220
CPU	Intel Core i9-11900K	$850
COOLER	MSI MAG CoreLiquid 360R AIO	$150
GPU	Nvidia GeForce RTX 3080 10GB	$2,600
RAM	32GB (2 x 16GB) G.Skill Trident Z Neo @ 4000MHz NEW	$550
SSD	1TB Gigabyte Aorus Gen4 7000s M.2 PCIe 4.0	$250
HDD	2x 3TB WD Blue 5400 HDD NEW	$210
OS	Windows 10 Home 64-bit OEM	$60
PRICE		$4,900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$829 - $1199
Samsung Galaxy S9 Plus 64GB 4G Mobile Phone
$960 - $1349
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PC BUILDER MASTERCLASS

Silence of the fans

Fans are so last year, right?

Computers can be noisy things, can't they? Whether it's the high-pitched whine of an AIO pump, the whirr of an HDD, or the roar of a gaming laptop's fans, we've all heard the effects of systems trying their best to mitigate heat. Thermal design has come a long way in the past few years, with each new generation of components producing less waste heat for the level of performance on offer.

Heat management is still an important business. If you're into overclocking, or use your system for resource-intensive tasks that put components under duress, you'll need a serious cooling solution. That means fans; usually lots of them. Case fans, radiator fans, CPU fans, GPU fans… even motherboards can now pack tiny fans for keeping your SSD cool.

Of course, those fans make noise, and the more fans you've got, the noisier it gets. So what happens when you don't have any fans at all? That's right, we're going back to the dark ages and building a fully passively-cooled PC. Not only will this machine have no fans, but we're also aiming to make it completely silent, so no HDDs allowed either. From pressing the power button to running stress tests, we don't want to hear a peep out of this PC.

How will we do this? A case with the potential for good airflow is the place to start, allowing for better passive convection of warm air out of the case. We'll also need a chunky passive cooler for our CPU, so thanks to Noctua for hooking us up with one. What else will we be using? Read on to find out.

PART		STREET PRICE
CPU	Intel Core i5-11600K	$430
RAM	16GB (2 x 8GB) G.Skill Trident Z Royal Elite DDR4-3600	$405
M/BOARD	Asus TUF Gaming B560M-Plus	$210
SSD	Samsung 980 Pro M.2 SSD 500GB	$160
PSU	Seasonic PRIME 600 Titanium Fanless	$375
COOLER	Noctua NH-P1	$200
CASE	Cooler Master Masterbox Q500L	[illegible]
TOTAL		$1,860

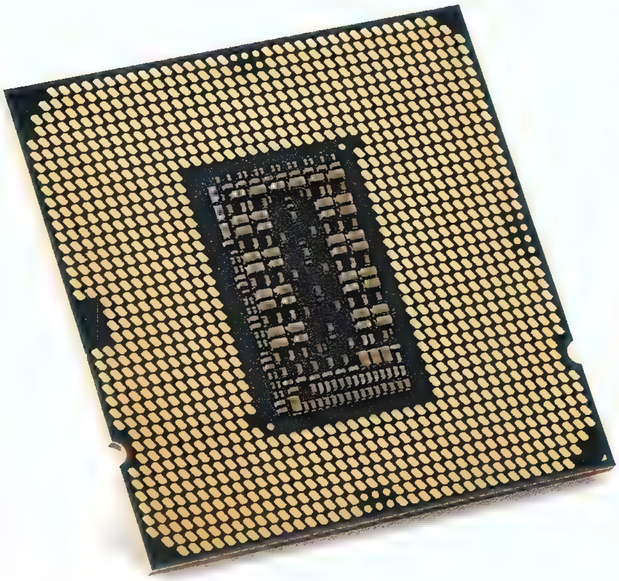
The hardware

Motherboard

ASUS TUF GAMING B560M-PLUS

Price: $210

A straightforward B560 motherboard with an mATX form factor for easy installation. The militaristic TUF branding might not be to everyone's taste, but we like these chunky heat sinks. It's got both DisplayPort and HDMI ports to support our integrated graphics, too. **asus.com**

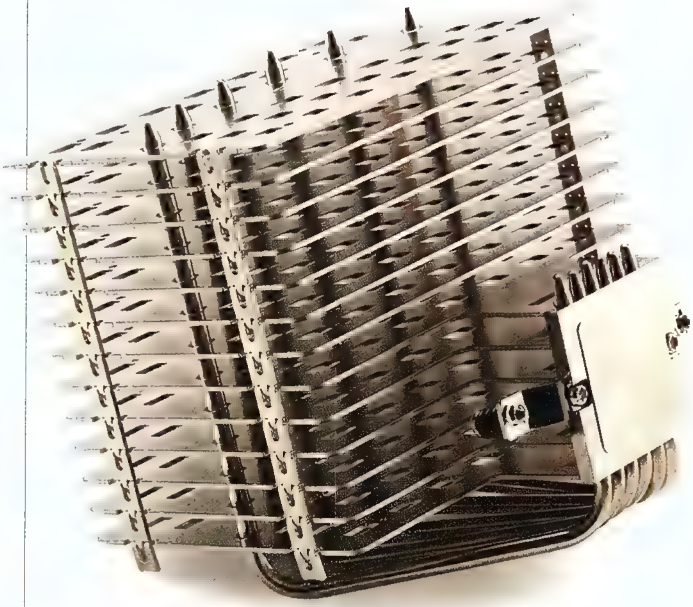


Processor

INTEL CORE I5-11600K

Price: $430

One of the best midrange CPUs on the market right now, the Core i5-11600K has mercifully been holding steady close to its RRP. It has everything we need for this build; PCIe 4.0 support, integrated graphics, and a speedy 4.9GHz boost frequency. **intel.com**

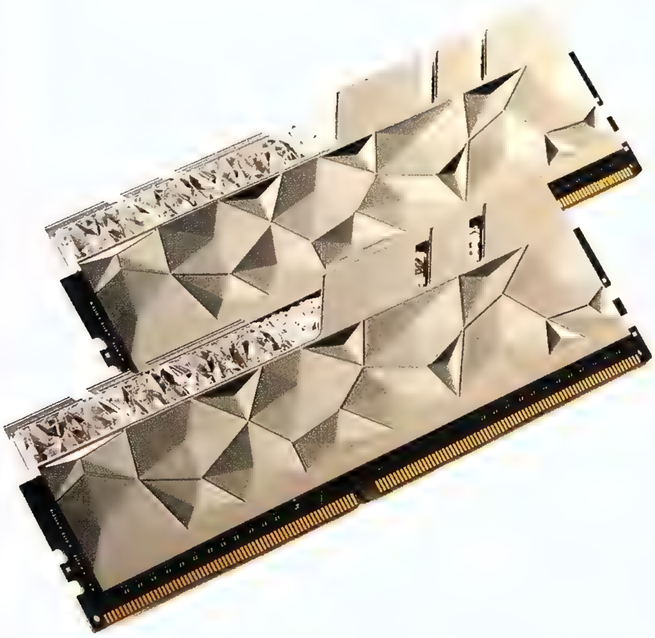


CPU cooler

NOCTUA NH-P1

Price: $200

This is the part that makes it all possible. Noctua's new passive cooler is a bit of a beast, barely fitting inside our case. It needs that bulk though, the NH-P1 has plenty of aluminum fins to better dissipate heat without active airflow. The SecuFirm2+ mount allows for compatibility with most modern CPU sockets. **noctua.at**



Memory

16GB (2 X 8GB) G.SKILL TRIDENT Z ROYAL ELITE DDR4-3600

Price: $405

We've got some seriously flashy memory in for this build. G.Skill's Trident Z Royal Elite drops the kitschy engraving of the original Royal RAM for a crystalline textured finish while keeping the RGB lighting. It's got some great performance behind it too; this memory is available up to a staggering 5,333MHz, but we're sticking with the more sensible DDR4-3600 version. **gskill.com**

V-NAND SSD
980 PRO
PCIe 4.0 NVMe M.2
SAMSUNG
500GB

Storage

SAMSUNG 980 PRO M.2 NVME 500GB SSD

Price: $160

With an 11th-generation Intel processor and a B560 chipset motherboard, we have full access to the almighty power of PCIe 4.0. We're taking advantage with a shiny new Gen4 SSD from Samsung, the 980 Pro. This gives us 500GB of crazy-fast storage, with maximum potential transfer speeds of nearly 7GB/s. **samsung.com**

PRIME
Seasonic

Power Supply

600W SEASONIC PRIME 600 TITANIUM FANLESS

Price: $375

Most 'fanless' power supplies are in fact not truly fanless; they merely have a zero-RPM option available, usually via a physical switch on the back of the unit that manually deactivates the fan. Seasonic's Prime 600 Titanium Fanless lives up to its name, though, with no fan and a perforated casing that allows built-up heat to more easily dissipate. **seasonic.com**

Case

COOLER MASTER MASTERBOX Q500L

Price: $80

Thanks to its fully perforated chassis, the Masterbox Q500L is an ideal choice for this build. Passive convection capabilities are a must-have here since we won't be using any fans whatsoever. The Q500L also has a moveable front I/O panel, PSU bracket, and rubberised feet that allow for a variety of orientations. **coolermaster.com**

A quieter place

How well will our silent system run?

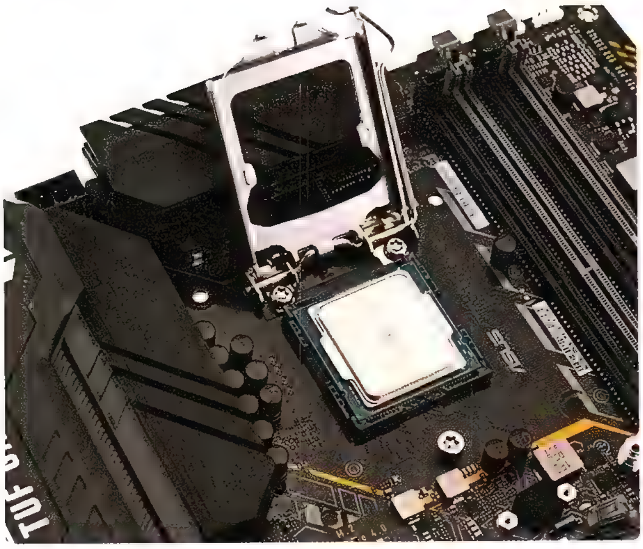
Length of time: 1-2 Hours
Level Of Difficulty: Medium

01 Filtered out

We'll start by stripping down this case. Unusually, a lot of what we remove here won't be going back into the build when we're finished; most notably the dust filters, as zero fans means zero airflow, and therefore near-zero dust intake. Removing them will help with natural convection, thanks to the Masterbox Q500L's heavily perforated outer frame. Two of the dust filters are magnetic, while the third is held in place with rubber pegs. You will also need a screwdriver to remove the window and the metal side panel, then the two SATA drive mounts (we won't need these), and the PSU cage. We'll be using this system on its side, as shown, so we also removed the four feet, which are secured via plastic push-pins. If you'd rather run your machine upright, leave these in place.

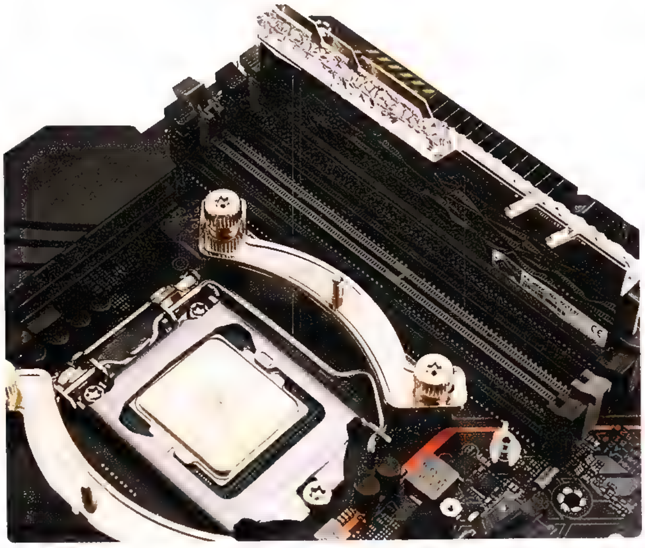
02 Fan down

The next thing to remove is the Cooler Master case fan that comes pre-installed in the Q500L. This is a fairly simple affair; just unscrew the fan at the four corners and lift it out of the case. Be careful here, as a slip of the screwdriver could lead to a nasty scratch on the case's metal exterior and we don't have dust filters to cover that up. We recommend keeping the fan in the case box (or with any other spare fans you have) so you don't lose it. If you want to leave the fan in place for optional use, you can – just remember to turn on the zero-RPM settings in the BIOS later on. You won't be able to reinstall the fan once the cooler is in place, so it's better to make this decision now.



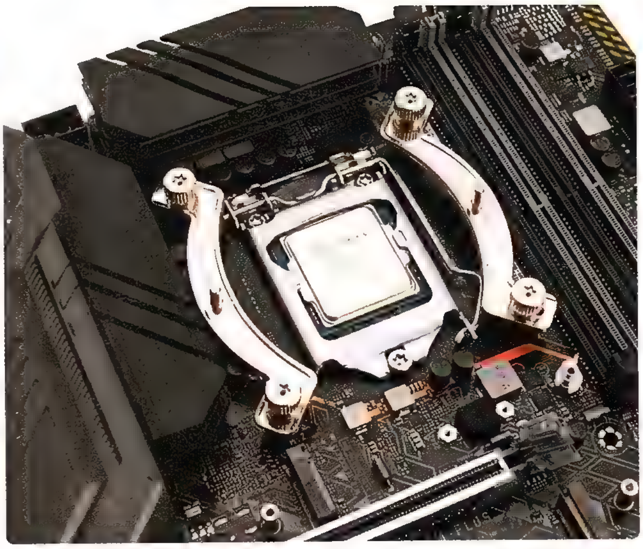
03 Processor problems

Over to our motherboard and processor. Unbox your components and place the motherboard either on an antistatic work surface or the box it came in. Remember when unpacking your board that the antistatic bag it comes in only prevents electrical buildup on the inside layer; the outside can still carry a charge, so be sure to wear appropriate footwear and ground yourself by touching a metal object frequently. To install the chip, release the metal retention arm from underneath the CPU bracket, free the bracket from the single Torx screw, lift it up, then drop the CPU into the socket, lining up the markings on the corner. Once in place, lower the bracket back into position and secure the retention arm. If you bought a brand new motherboard, the plastic cover on the CPU socket will snap off automatically.



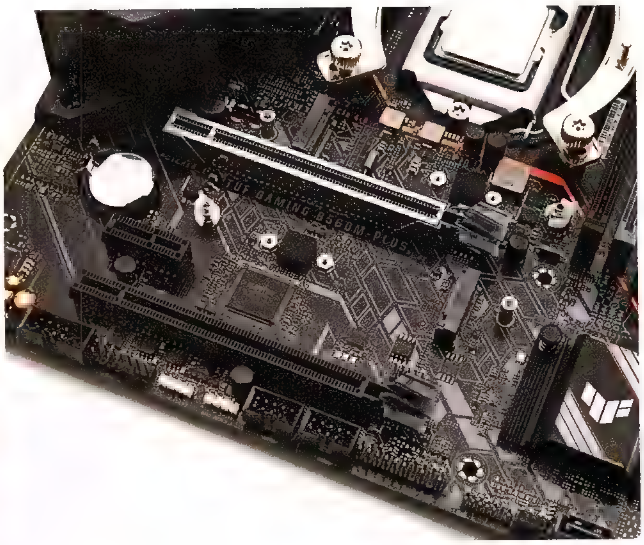
05 All that glitters

It's time to fit our beautiful (or hideous, depending on your taste) memory. Thankfully, this is a fairly straightforward process; release the plastic clasps on the DIMM slots, and line up each stick of RAM using the divot in the middle of the socket. Push these firmly down at both ends until the clasp shuts and the memory clicks into place. For optimal memory performance, Asus recommends using slots A2 and B2, which are the second and fourth DIMMs from the CPU socket respectively. Helpfully, these are easy to spot; not only are they labeled directly on the PCB, but they are grey in colour rather than the solid black of slots A1 and B1.



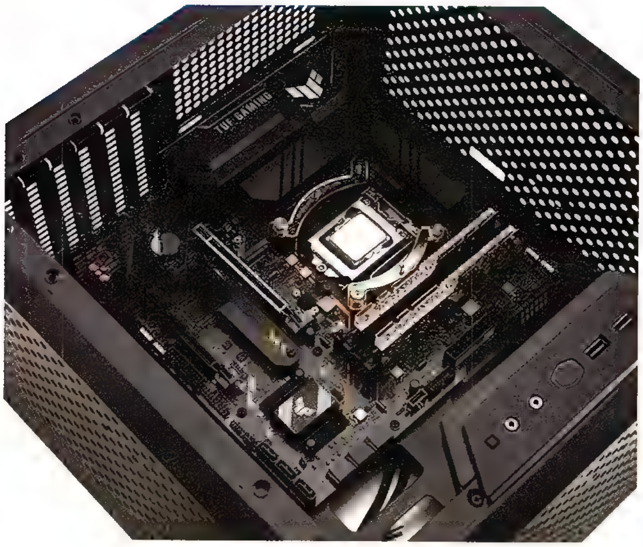
04 Adaptable mounting

Like all of Noctua's excellent cooling solutions, the NH-P1 comes with a variety of brackets for installation on different motherboard configurations. We'll need the LGA 1200 Intel bracket, which is clearly labeled. To install this, fit the Intel backplate on the underside of the motherboard as shown by the instructions, then flip it over to put the black plastic risers on each screw mount. Once the risers are in place, add the two mounting bars so that they curve outwards from the CPU socket, and secure them with the provided thumbscrews. These can be tightened with the NH-P1's included screwdriver, which you will also need to install the cooler itself. Ensure that the brackets are secure without any wobble, but don't over-tighten the screws as you could risk damaging your components.



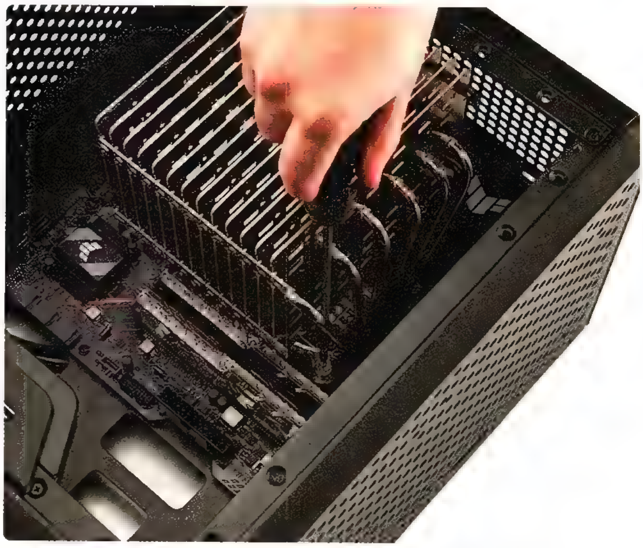
05 Shields off

Next up is our super-speedy solid-state drive. To do this, remove the heat sink from the M.2 slot closest to the motherboard by unscrewing it at both ends with a small Phillips-head screwdriver. We're actually going to move the heat sink and use the slot further from the CPU, as it will be easier to access below our chunky cooler and will hopefully give the drive a bit more breathing room. Installing the drive is child's play; simply lower it into the M.2 slot at a 30-degree angle, then push it down and secure it by rotating the plastic clasp at the opposite end clockwise until it locks in place – there's not a tiny, frustrating M.2 screw in sight! Next, remove the plastic cover from the heat shield's sticky pad, and screw it back down over the SSD at both ends.



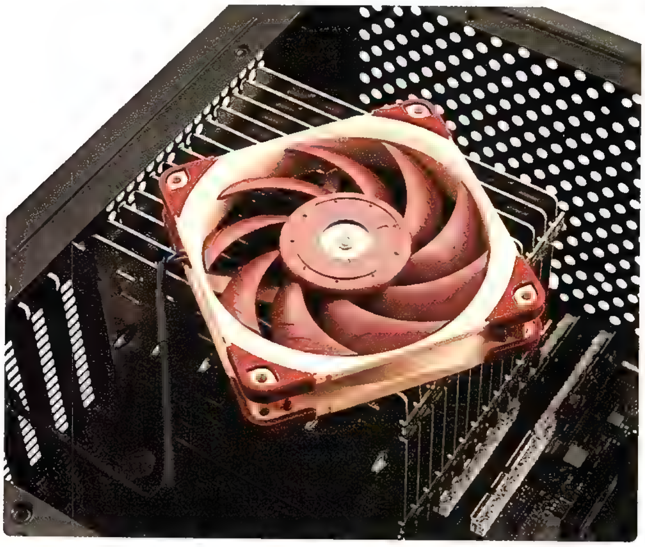
07 All aboard

It's time to install our motherboard. You'll likely need to reposition some of the Q500L's mounting standoffs to do this properly, as the default configuration is for ATX motherboards. There are three you can move, all in a row furthest away from the rear I/O port. If you're unsure, position the motherboard inside the case and see which holes are missing standoffs beneath them. You'll need an adjustable spanner or a pair of pliers to unscrew these unless you have the right size of hex socket driver. Once your standoffs are all correctly aligned, lower the mobo into place on the central mounting peg and line up the rear I/O before securing it with the provided screws.



08 Fin fit

Mounting the NH-P1 cooler can be tricky, but that's mostly just down to the sheer build of this fan-free heat sink. It's a single heavy unit, so be cautious not to drop it on your motherboard, or you may hear the terrifying sound of a PCB cracking in two. Apply a pea-sized blob of thermal paste (we're using Noctua's excellent NT-H2 compound, which comes free with the cooler) to the center of your CPU, then position the cooler over it and gently push down to spread it out. The Noctua screwdriver can then be used to reach down between the chunky metal fins and secure the two spring-loaded screws to the bracket we fitted earlier. These screws stop turning once they are fully secured, so there's no risk of over-tightening here.



09 Clip and clasp

For those after a truly fanless PC, skip this step. If you like the idea of having options and are willing to set up zero-RPM modes through the BIOS, though, stick around. We've got a single NF-A12x25 LS-PWM low-noise fan from Noctua, which can be installed directly onto the cooler for a bit of powered airflow when needed. This fan is near-silent, though costs $60, making it an good choice for a semi-fanless machine. To install it, insert the tips of the two fan clips into 'hole set 1' on the side of the cooler above the RAM, then hold the fan against the cooler and use the clips to lock it into place.

10 Power up

The final component will be powering this build without so much as a whisper: Seasonic's Prime fanless power supply. This PSU's hole-covered chassis lets us see a lot more of its guts than most power supplies, which hardware aficionados may find interesting. We're more on the practical side of things right now though, so let's screw it into the PSU cage we removed from the case earlier using the included Phillips screws. It's best to also fit your power cables now, as we're running out of space to work inside the case. Fortunately, we only need two: a single eight-pin CPU power cable and, of course, the bulky motherboard ATX cable.

11 Bricking it

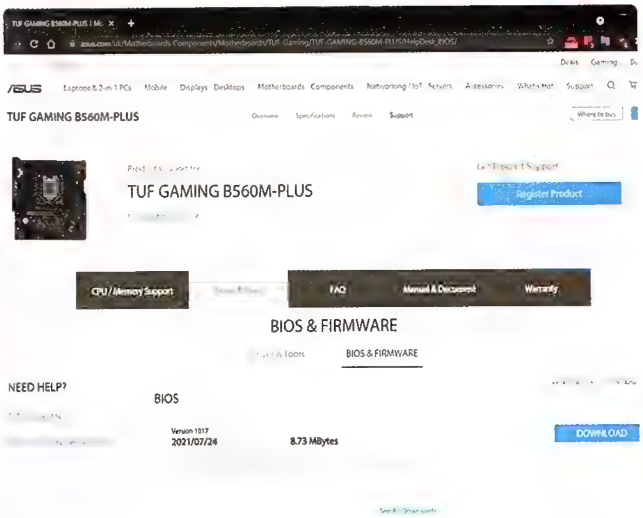
Let's situate this transparent power brick inside our case. While the Q500L's versatile design means that the PSU can be mounted in a variety of different positions within the case, we'll be sticking to the default configuration here and placing it towards the front. You should be able to see markings on the chassis where it was originally fitted; use these holes, along with the screws that held it in place to begin with, to mount it. Again, be careful here; the PSU is heavy, and dropping it could damage your motherboard. Once the PSU is secured, plug in the extension kettle cable built into the case.

12 Cable capers

With all our parts in place, we need to plug everything in. Route the cables from the PSU across the rear of the motherboard plate and through the cutouts to plug them into the appropriate sockets, securing them to the clips with cable ties as you go. We don't have many cables here, so keeping everything tidy shouldn't be hard. The same goes for our front I/O cables; there's not much to do here, simply plug in the HD audio and USB cables to the relevant motherboard connectors, along with the delicate wires for the buttons and LEDs.

13 Reconstruction

It's time to put our case back together again. We're not doing much; only the metal panel and window need to be fitted, but be careful not to over-tighten the screws on the panel. Doing this will warp the rubber grommets acting as the machine's feet and might result in a wobbly PC. Store the surplus parts in the Q500L's box, in case you decide you need them later. If you've followed our optional steps to fit fans in this machine, you'll want to put the dust filters back in place too.


TUF GAMING B560M-PLUS | Mo
asus.com/uk/Motherboards-Components/Motherboards/TUF-Gaming/TUF-GAMING-B560M-PLUS/HelpDesk_BIOS/
Deals
Gaming
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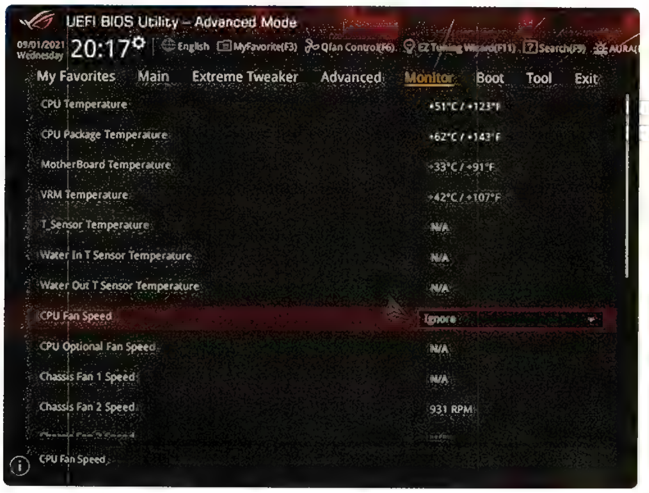
Laptops & 2-in-1 PCs
Mobile
Displays
Desktops
Motherboards
Components
Networking / IoT
Servers
Accessories
What's Hot
Support
TUF GAMING B560M-PLUS
Overview
Specifications
Review
Support
Where to buy
TUF GAMING B560M-PLUS
Register Product
CPU / Memory Support
FAQ
Manual & Document
Warranty
BIOS & FIRMWARE
BIOS & FIRMWARE
NEED HELP?
BIOS
DOWNLOAD

Version 1017
2021/07/24
8.73 MBytes

14 Easy flash

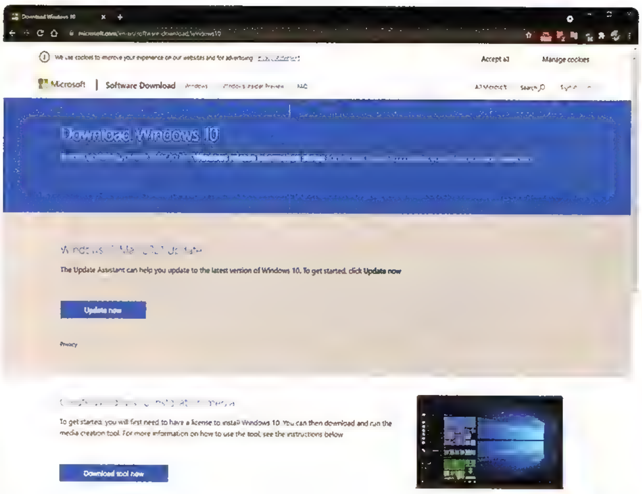
Our PC is finished, but we're not. It's always a good idea to update the BIOS of your motherboard when you complete a build. It isn't a difficult process and helps system stability. Hop onto a different PC and download the latest BIOS firmware from the TUF Gaming B560-M Plus's support page on the Asus website, then transfer it to a blank USB flash drive. Enter the BIOS on your newly-built system and plug in the drive, then hit 'EZ Flash Utility'. Select the file and begin the update process (this should only take a few minutes). If your board is new, it should come pre-flashed; used motherboards might need an older 9th- or 10th-gen Intel CPU installed first to update them for 11th-gen compatibility, so bear this in mind.



```
CPU Temperature                    +51°C / +123°F
CPU Package Temperature            +62°C / +143°F
MotherBoard Temperature            +33°C / +91°F
VRM Temperature                    +42°C / +107°F
T_Sensor Temperature               N/A
Water In T Sensor Temperature      N/A
Water Out T Sensor Temperature     N/A
CPU Fan Speed                      Ignore
CPU Optional Fan Speed             N/A
Chassis Fan 1 Speed                N/A
Chassis Fan 2 Speed                931 RPM
CPU Fan Speed
```

09 Dead fan down

If you've reached this point and don't have any fans installed, the motherboard will throw a tantrum and refuse to boot beyond the BIOS. This is because it's (rightfully) concerned about your CPU burning out, but fortunately, there's a solution. In the advanced BIOS settings, under 'Monitor', you can enter the Q-Fan configuration options. Here, you'll find a setting for adjusting the minimum CPU fan speed; it's set to 200rpm by default, but as we're not using a CPU fan, you can go ahead and switch this to 'Ignore'. If you are using fans, take this opportunity to adjust your fan curves and set up zero-RPM modes.



The Update Assistant can help you update to the latest version of Windows 10. To get started, click Update now

To get started, you will first need to have a license to install Windows 10. You can then download and run the media creation tool. For more information on how to use the tool, see the instructions below

10 Hello world

we're nearly there! Your last step is to install Windows 10 (or your OS of choice) on your finished system. To do this, take the USB flash drive you used earlier and wipe it, making sure it is set up with a FAT32 format. Head to the Microsoft website and download the Windows 10 Media Creation Tool to your drive, then plug it into your new PC and set it as the priority drive in the BIOS boot settings. Upon launching, you should be greeted with a guided installation process; you can proceed without a product key and activate your copy of Windows 10 later to fully unlock its features. Job done!

The silent master?

It certainly *feels* a bit strange to hit the power button on a freshly assembled build and hear absolutely nothing. It's actually not that strange, but the usual cause is that the system is failing to boot because we have a loose connection or a faulty part. Mercifully, our fanless PC booted on the first attempt, and we enjoyed the manifold pleasures of installing Windows without any fan noise to irritate us.

Before we jump into the numbers with our benchmark testing results, we feel compelled to say that this system exceeded our expectations in numerous ways. Yes, it did get pretty warm, but we were prepared for that; in a well-ventilated room, the Core i5-11600K idled around 40°C, which is considerably above average, but completely within acceptable parameters. Running the CPU at that sort of temperature for extended periods isn't likely to cause any harm to the processor.

The Seasonic Prime Titanium PSU performed even better, with thermals sitting only marginally above average. This system doesn't need anywhere close to the 600W ceiling, to be fair, so it's perhaps not surprising, but we were still pleased with its performance. We noticed an almost imperceptible whine from the PSU when the system was in sleep mode, but we suspect this was caused by the extension power cable built into the Masterbox Q500L.

Our SSD ran impressively cool, staying below 45°C even during large transfer tests; a testament both to Samsung's build quality, and the effectiveness of the M.2 heat shield included with the TUF motherboard. Overall, there was plenty to love about this build. Barring the big, heavy cooler, it was a quick and simple machine to put together, with little cable management needed after we were done. We'd call it a resounding success, but let's see those testing figures first.

Benchmarking results

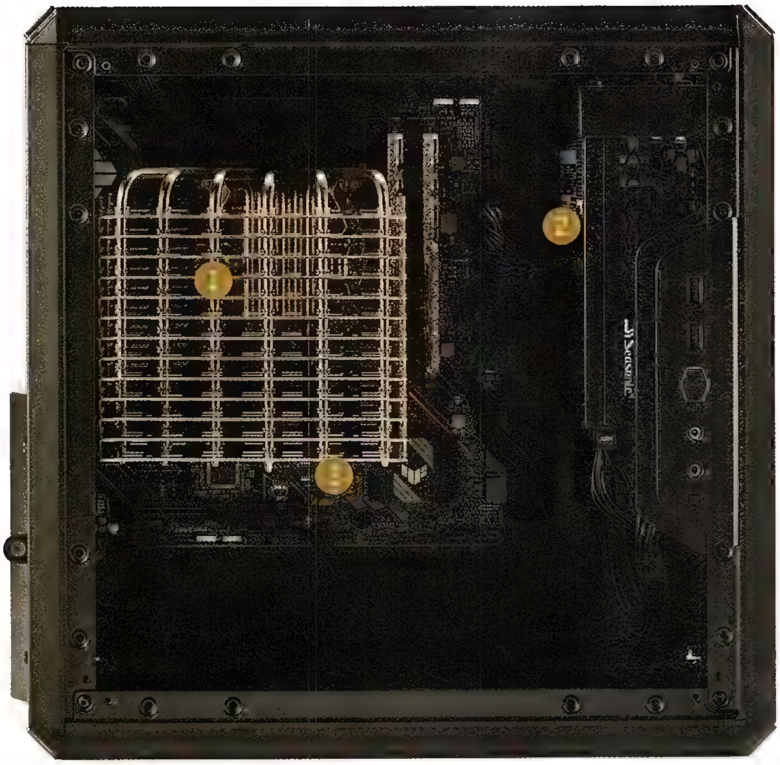
The results were a mixed bag. The Core i5-11600K performed admirably, with little performance loss, despite the fanless cooling solution. CPU temperatures in games and benchmarks ran high, generally sitting around 80°C, but never verged into genuinely concerning territory.

The Samsung 980 Pro dominated here, pushing the limits of PCIe 4.0 to deliver blisteringly fast transfer speeds. It sat much closer to its theoretical ceiling with sequential write tests, falling short of the 5GB/s maximum by less than 100MB, while sequential reads were just a little slower, falling nearly 250MB/s short of the 7GB/s top speed. Still, these are both staggeringly fast transfer speeds that are certainly not to be sniffed at.

Graphical tests were less impressive, unsurprisingly. The UHD Xe 750 integrated graphics are decent, certainly a major step up from UHD 630, but, as you can see from our results, they fell short of offering a practical 1080p gaming experience in all but the least demanding titles. Dropping the graphical settings to minimum in *Rise of the Tomb Raider* still only produced framerates of around 25fps on average.

But 720p is an option; dropping the graphical settings along with the reduced resolution made our benchmarking games playable at 30fps, with resource-light esports titles likely to run higher. *Fortnite* and *Valorant* were playable in 1080p, with the latter maintaining 30fps at medium settings without putting too much thermal stress on the processor and memory.

However, the thermal performance of the overall system throughout our game benchmarking process was solid.



① The NH-P1 dominates the interior of this case.

② Seasonic's fanless PSU sits right against the perforated casing of the Q500L.

③ Our SSD nestles away underneath the cooler, but it didn't have any temperature issues.

FANLESS GPUS?

In order to keep this build totally fanless, we had to forego a graphics card.

This was a blessing in disguise at the time, because it meant we didn't have to enact a dark ritual to summon an appropriate GPU in these troubled times. If you're willing to brave the waters of eBay and do want to include a GPU, though, you have a few options here. A handful of old Nvidia GT 1030 and 1050 cards came in passively-cooled models, such as the MSI GeForce GTX 1030 2GH LP OC. These generally aren't too difficult to find used and are likely to cost you around $130.

As you can tell from our benchmark results, this isn't a system built for playing games. The GT 1030 is only just capable of playing games at 1080p, so the performance gains over these integrated graphics will be small. If you're absolutely committed to gaming on a silent rig, a more powerful option is the GTX 1650 KalmX from Palit, but these are difficult to track down. We contacted Palit to discuss the card (it is, to date, the most recently released fanless GPU), but unfortunately the manufacturer no longer produces it and currently has no plans to produce new KalmX cards.

A potential solution is to passively cool a GPU yourself, although this requires a lot more work. You could do this by water-blocking the GPU and connecting it to a large fanless radiator to liquid cool it, or potentially by purchasing a dedicated passive cooler. A small number of manufacturers sell these, such as the Morpheus II Core from Raijintek, which is compatible with cards up to the GTX 1080. Bear in mind that both of these options will require you to either buy a stripped GPU or remove the aftermarket cooler yourself.

Yes, it did get pretty warm, but we were prepared for that; in a well-ventilated room, the Core i5-11600K idled around 40°C, which is considerably above average, but completely within acceptable parameters. Running the CPU at that sort of temperature for extended periods isn't likely to cause any harm to the processor.

Mainboard temperatures never ran in excess of 50°C (that's likely due to the excellent natural ventilation of the Q500L with its dust filters removed) and the case's metal outer chassis was only slightly warm to the touch even after an hour of intermittent load testing. The acrylic panel of the Q500L sits very close to the top of the NH-P1 cooler, which was a concern, but it never got too toasty. Even the cooler itself wasn't too hot to touch.

As a final exercise in sadism, we slapped Prime95's torture test on and left this machine to stew for half an hour. Did it crash? No, shockingly enough. Temperatures peaked at exactly 100°C about eight minutes in and sat there for the remainder of the test, taking roughly 12 minutes to return to idle numbers afterward. Needless to say, we were very pleased with this.

Closing remarks

Let's call this build what it was: an unmitigated success, provided you don't want tons of processing power or gaming capability. For a silent home office PC, though, this system works wonders. Solid, reliable performance without the slightest whisper of a fan was our goal, and we're happy to say that goal has been achieved.

Mind you, we imagine we'd have seen a better performance with a few fans in here. Even a single case fan would likely have provided a significant boost to the cooling potential of the Q500L, creating airflow where there is currently none. We'd be slightly concerned about running this PC on a hot summer's day, too; an overcast September afternoon is one thing, but if you live in a sunny state, keep the AC on. ■

	Zero-point	Silent Master
Cinebench R15 Multi (Index)	1,152	[illegible]
CrystalDisk QD32 Sequential Read (MB/s)	3,400	[illegible]
CrystalDisk QD32 Sequential Write (MB/s)	1,720	[illegible]
Rise of the Tomb Raider (fps)	[illegible]	10
Total War: Warhammer II (fps)	[illegible]	11
Tom Clancy's Ghost Recon Wildlands (fps)	[illegible]	7
3DMark: Fire Strike Extreme (Index)	[illegible]	2,168

Our zero-point consists of an AMD Ryzen 5 1600, 16GB Crucial Ballistix Sport LT @ 2666MHz, an EVGA GeForce GTX 1060 3GB and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

HOW-TO

TOP TIPS TO TACKLE TECH TROUBLES

Quick Tips

The problem solvers

The *APC* team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Cannibalising old components

I have some components lying around I'd like to reuse. I would like to consider utilising some or all of the following components: a Rocketfish RF-Fulltwr Aluminum Full-Tower Case (huge, great reviews and mod-able), a barely used 700-watt OCZGXS700 PSU, and a new A8-7670k CPU I bought as an impulse buy four years ago (along with a motherboard I can no longer find).

Alternatively, I have a new Asrock 775Dual-Vista 775 MB motherboard I could build a system around, but my first thought is to use the A8 CPU, case, and PSU for a server build. I also have an Asus U3S6 PCIe4 x4 card that offers USB 3.0 ports.

I found a review from 2016 where the processor was purchased for a small home virtualisation server and was capable of handling Plex in conjunction with a repurposed Radeon gaming card, making it capable of handling simultaneous playback and transcoding to multiple devices in HD. It was also very quiet and capable of mild overclocking. It was described as an "awesome budget CPU" for utility/workhorse purposes. Would that review still apply today, or can I use the case and PSU in an all-new build? Your thoughts would be appreciated.

Dean Johnson

***APC* Responds:** That's quite an eclectic mix of components, Dean. Your first thought is a good one – ditch the Asrock motherboard, which is too old, and look at pricing a system around the A8-7670k CPU instead. That is easily powerful enough for server and Plex duties, without needing a secondary graphics card, particularly if you optimise your media to minimise the need for transcoding.

You'll need to source a compatible motherboard and RAM, it will need to be a Socket FM2+ and we recommend the A88X chipset. Asus's A88XM-A/USB 3.1.

The board supports up to 64GB DDR3 RAM across four DIMMs, and a compatible 16GB kit (2x 8GB) can be found at **www.crucial.com** (use its memory finder to search for 'A88XM-A/USB 3.1' to pick out matched RAM). This should be ample for your server needs, and there are still two spare slots available to add more, should you need them later.

It also has six onboard SATA ports, which gives you plenty of scope for storage. Look to populate these with NAS-optimised drives, such as Western Digital's Red range – consider a WD Red SSD boot drive for extra responsiveness.

There are six accessible USB ports (2x USB 3.1, 2x USB 3.0 and 2x USB 2.0) with scope to add further USB 2.0 and USB 3.0 via internal connectors. Your PCIe USB 3.0 card would fit the board but is likely to be redundant. However, it's there if you are still short of rear USB ports.

Finally, in your email, you touched on FreeNAS as a possible server OS. Instead we recommend Ubuntu Server instead. This is more universally supported, can be configured to run headless via the web-based cockpit UI, and is perfect for your server needs.

Monitor upgrade query

Big fan of your magazine. Windows 11 is coming, and this means a new PC – no problem. I have two 10-year-old 27-inch Dell displays – no problem. My eyes... now that's the problem. I've been looking for 32-inch displays and found the BenQ PD3200U, but it's five years old. I don't play games, just use it for Excel, email, YouTube, etc. Can you recommend something equivalent to the BenQ, but a little more future-proof?

Derek Lane

***APC* Responds:** The original release date of a monitor isn't necessarily something to worry about, Derek. Monitor technology doesn't evolve at the same rapid pace as PC tech, and given your modest requirements, there's little point splashing out for cutting-edge features you'll never need.

Ideally, what you need to do is visit a local store and test the monitors on display, to see how your eyesight perceives the picture on them. This should be your primary thought when choosing a screen.

The key drawback with the PD3200U is that it only supports HDMI 2.0 and DisplayPort 1.2. These technologies are fine for everyday use but have been superseded by HDMI 2.1 and DisplayPort 1.4 respectively.

The latter offer greater bandwidth, so if you're planning to futureproof your purchase with one eye on greater refresh rates (which may help with your eyesight), then an updated version of the PD3200U is BenQ's EW3280U. At around $700, the price is identical, and you get one DisplayPort 1.4 and one USB-C port in addition to two HDMI 2.0 ports. It's an IPS display too, so works well in all lights. See **www.gamesradar.com/benq-ew3280u-review** for a full review.

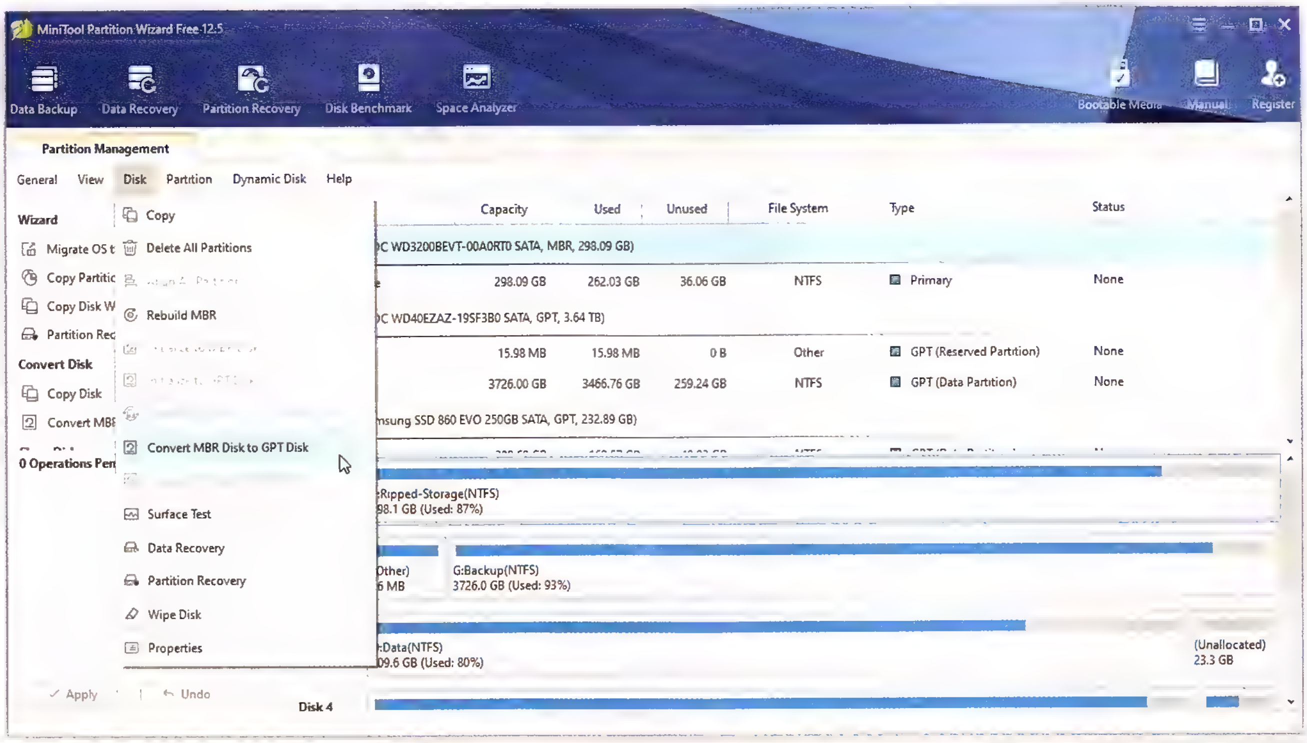
If you can get to test them in a live environment, consider its cheaper little brother, the EW3270U. The key difference is that it's a VA, rather than an IPS panel, so best suited to dimmer environments. But given the potential saving, it's worth checking both out if you can.

Windows 11 sleep problem

I've recently encountered a sleep problem in both Windows 10 and 11. I've been bouncing between Windows 10 and successive Insiders Builds of Windows 11 to check my 2018 Skylake X system could run Windows 11. On my first attempt, I discovered an error with Cyberlink Power DVD 20 telling me I didn't have a valid graphics driver. I've tried it three times and followed instructions given to me by Cyberlink, but it didn't work, so went back to Windows 10.

This has happened on subsequent tests of new Insider Builds, even after switching from Cyberlink to Nero 14 Blu-ray. I then started getting errors in Windows Live Mail when clicking links, so I rolled back to Windows 10 from an Acronis backup and then found a new build of Windows 11. I installed and everything was working okay... or so I thought. Now, I find whether I'm running Windows 11 or Windows 10, that when I put the computer to sleep it appears to do so before shutting down completely after three seconds.

I've tried a recent BIOS update and tweaking the only setting related to power in the BIOS, but no luck. No luck either with any combination of power settings in Windows via the Control Panel. It's only a minor


MiniTool Partition Wizard Free 12.5
Data Backup
Data Recovery
Partition Recovery
Disk Benchmark
Space Analyzer
Bootable Media
Manual
Register
Partition Management
General
View
Disk
Partition
Dynamic Disk
Help
Wizard
Migrate OS t
Copy Partitic
Copy Disk W
Partition Rec
Convert Disk
Copy Disk
Convert MBF
0 Operations Pen
Copy
Delete All Partitions
Rebuild MBR
Convert MBR Disk to GPT Disk
Surface Test
Data Recovery
Partition Recovery
Wipe Disk
Properties
Apply
Undo
Capacity
Used
Unused
File System
Type
Status
C WD3200BEVT-00A0RT0 SATA, MBR, 298.09 GB)
298.09 GB
262.03 GB
36.06 GB
NTFS
Primary
None
C WD40EZAZ-19SF3B0 SATA, GPT, 3.64 TB)
15.98 MB
15.98 MB
0 B
Other
GPT (Reserved Partition)
None
3726.00 GB
3466.76 GB
259.24 GB
NTFS
GPT (Data Partition)
None
nsung SSD 860 EVO 250GB SATA, GPT, 232.89 GB)
:Ripped-Storage(NTFS)
98.1 GB (Used: 87%)
Other)
6 MB
G:Backup(NTFS)
3726.0 GB (Used: 93%)
:Data(NTFS)
09.6 GB (Used: 80%)
(Unallocated)
23.3 GB
Disk 4

Minitool Partition Wizard makes conversion to GPT easy.

inconvenience, but I want to keep my PC off or asleep when not in use. Any help would be appreciated.
Phillip Tursky

***APC* Responds:** The sleep problem may be linked to the Intel Management Engine driver. This may have been wiped out by a generic Windows 11 driver that doesn't work with your 6th generation CPU. You could try reinstalling it via **www.intel.com/content/www/us/en/download/19406/** (remove the current version of IME via Device Manager under System devices, then install the downloaded driver).

However, given that Microsoft has announced that Windows 11 won't be supporting Sky Lake processors, the best thing to do is reinstall Windows 10 from scratch. Given all the switching between Windows 10 and 11, you've probably garbled parts of your current installation. Rather than try to unpick them, we recommend removing all traces of Windows 11 from your system.

If your Acronis backups go back far enough, roll back your PC to the point in time before you first attempted to install Windows 11. This may be sufficient to wipe out all those changes and restore the sleep function to its proper working condition.

If not, follow one of our recent reinstall guides to back up, wipe your Windows 10 partition and then reinstall Windows 10 from scratch using the latest version of Windows 10 as offered by the Windows Media Creation tool (**www.microsoft.com/software-download/windows10**).

Once Windows has been restored and you've verified things are working correctly again, do not continue experimenting with Windows 11 Insider Builds. While you may have been able to install Windows 11 successfully on your Sky Lake system, unless Microsoft has a sudden change of heart, you'll be getting no official support going forward.

Secure boot query

I'm in no rush to get Windows 11, but I do need some help. I have the necessary hardware spec, an Asus TUF Gaming X570-Plus and AMD Ryzen 7 5800X, but Microsoft's upgrade tool keeps telling me I don't have Secure Boot set up. I've done some sleuthing and suspect two things are holding me back: first, I need to have my drives all use GPT instead of MBR, which requires the mbr2gpt tool from the command line. But since I followed a site to bypass login, I can't boot to the command line at startup. Please help!
Kirke Holmes

***APC* Responds:** The fact you've bypassed the login screen won't prevent you from converting to GPT, because mbr2gpt should ideally be run from the Windows rescue (PE) environment, which means creating Windows installation media using the Media Creation Tool from **www.microsoft.com/software-download/windows10** (a USB flash drive is much quicker than DVD).

That said, you can convert MBR drives to GPT without having to go near the command line. MiniTool Partition Wizard Free (**www.partitionwizard.com**) is capable of performing this task. Make sure you select the entire disk rather than just a partition on it, then choose 'Disk > Convert MBR Disk to GPT Disk' and follow the prompts. Before doing so, take a full drive image of the disk using a tool such as Macrium Reflect (**www.macrium.com/reflectfree**) in case something goes wrong.

You shouldn't need to convert all your disks to GPT, just the disk(s) containing your Windows drive and any relevant boot partitions. Once done, navigate to the UEFI BIOS Utility, switch to the Boot section, and disable CSM. Next, set Secure Boot to 'Windows UEFI Mode', save your changes, and exit, and Windows should boot as normal. When you next run the upgrade checker, you should be clear to install Windows 11 when it's out.

Finally, if you want to restore the login prompt, press Win-R, type 'control userpasswords2', and hit Enter. Make sure 'Users must enter a username and password to use this computer' is ticked and click Apply followed by OK. When you next reboot, the login prompt will be restored. ■

Windows 11 and security

What is a TPM, anyway?

Windows 11 promises to be more than just a pretty face.

Windows 11 is here. For new PCs it's coming out this year, and Windows 10 users will be able to get a free update. That is, unless their PC is not supported – and many PCs will not be.

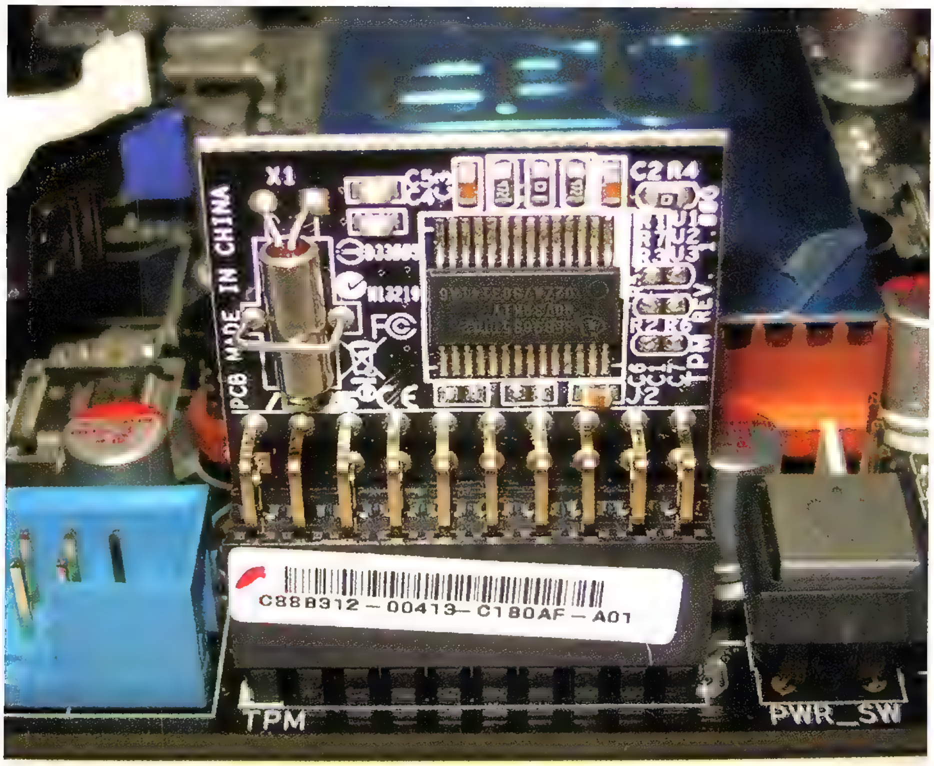
As of the time of writing, Windows 11 has a hard requirement of a Trusted Platform Module (TPM) version 2.0, something that many older PCs lack (as well as some new ones, especially ones that have been self-built). It will check during the install if that's present, and kick you out if you don't have it.

We say 'at the time of writing' because this situation is fluid and Microsoft's messaging has been somewhat confusing. Originally, only TPM version 1.2 was required. Then that was changed to 2.0. Then it was revealed that some computer manufacturers could forgo the TPM requirements, and users of preview builds of Windows 11 found it was quite trivial to bypass the check and the OS would work fine without the module. Then it was found that even some systems that met all the qualifications for the OS would register as non-compatible due to the CPU (Intel NUCs, for example, are often coming up as incompatible despite meeting every criteria for the operating system).

We're not sure where this is all going to land in the end, but we thought we'd take this moment to look at Windows 11 security, and the reasons Microsoft is nominally demanding that a TPM be present.

All about TPMs

TPMs were first introduced in 2009, with version 1.2. The specification was updated in 2014 to 2.0, with widespread adoption starting around 2016 (so if your PC is older than that, there's no way it will meet the official requirements of Windows 11). In many cases a TPM is a physical chip attached to the motherboard of your computer, but in some cases it's instead implemented in the firmware on the CPU. Either works for Windows 11.



A discrete TPM on a motherboard Pic: Wikimedia Commons

A trusted platform module does a number of things related to security. Its core features include:

- It creates unique cryptographic keys for the device it's attached to (including the specific hardware and software configuration), which allows third party software to check that it's talking to the 'real' device rather than a hacker trying to spoof the device, and to ensure that the software has not be changed or modified – this includes the computer's firmware. This is used in Secure Boot (see following page), Windows Update and for things like Office365 licensing and for other services where the software provider wants to be sure that they're talking to the right computer and that communications and software haven't been tampered with. It's also used in full disk encryption utilities like BitLocker and dm-crypt, where the keys to decrypt the hard drive are stored securely in the TPM, as well as Windows Hello, which stores your biometric data in the TPM.
- A hardware random number and cryptographic key generator,

which is designed to prevent the spoofing of software-based random number sequences. Many programs will use a TPM to generate keys, though some still prefer to use software.

These features are designed to create "trust" – hence the name. They create a bridge between the hardware, software, and the services that talk to the computer to ensure that everybody is who they say they are and that there have been no modifications to the system that might compromise its integrity, such as firmware-based malware or modifications to any installed applications or the OS.

The security features of Windows 11

Which brings us to the security of Windows 11. Oddly enough, Windows 11 brings very little that is completely new to the security of the operating system, but it does implement a lot of existing systems more universally. Things like Windows Hello, Secure Boot, virtualisation-based security (VBS) and hypervisor-protected code integrity (HPVI) were all features that were available in Windows 10 for those that bothered to implement them, but will be more broadly available in Windows 11. According to Microsoft, historically companies that implemented these features saw a 60 percent reduction in malware infections, so it wants to ensure that everybody is using them.

So let's take a look at them in turn:

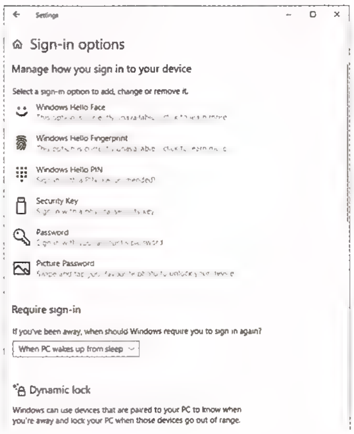
Windows Hello

From a user perspective Windows Hello is probably the most visible security feature of the operating system. Windows Hello is available in Windows 10, found in Start > Settings-Account > Sign-in options. It allows you to sign in via a fingerprint, facial recognition or a pin. Windows Hello on Windows 10 can use but does not require a TPM.

Secure Boot

Originally launched with Windows 8, Secure Boot was and remains controversial since it complicates the installation of other operating systems (though the problem has largely been solved for Linux), but Microsoft sees it as a key pillar in its defence against malware that infects the system firmware or the pre-OS environment such as the boot loader.

Windows Hello is already right there in Windows 10, but Windows 11's TPM requirement will make it more secure.



Sign-in options

Manage how you sign in to your device

Select a sign-in option to add, change or remove it.

Windows Hello Face

Windows Hello Fingerprint

Windows Hello PIN

Security Key

Password

Picture Password

Require sign-in

If you've been away, when should Windows require you to sign in again?

When PC wakes up from sleep

Dynamic lock

Windows can use devices that are paired to your PC to know when you're away and lock your PC when those devices go out of range.

With Secure Boot, the computer's unified extensible firmware interface (UEFI) checks the signature and checksum of any program loaded by the firmware against a list of 'approved' programs stored in the TPM. If the program is unapproved – for example, if the bootloader has been modified (which will change its checksum) then it simply will not load.

Virtualisation-based security (VBS) and hypervisor-protected code integrity (HVCI)

These sound terrifying, but they're not something you'll have to think about much as a user. What they do is allow Microsoft and software developers to run programs in a protected sandbox that is protected from interference by other programs. It's particularly useful, for example, for security solutions that need to be kept free from tampering by hackers who would try to disable or modify them.

It uses the built-in virtualisation features of current Intel and AMD processors as well as Microsoft's Hypervisor capability, which is commonly used to create "virtual PCs" running inside the current PC. With HPVI, code can be set to run only if it has been signed and it will also check all the operating system components inside the virtualised PC to ensure that they haven't been modified.

The upshot is that code running in VBS with HPVI enabled is protected from modification or infection by malware. As a user, it's not something you have to enable or think about, but having it there ensures that, say, your security suite cannot be compromised and disabled by hackers.

Much like Windows Hello, VBS/HVCI does not technically require a TPM, but having one is highly recommended. Storing the signatures for checking application integrity on the TPM is far more secure than storing them on the hard drive in the OS.

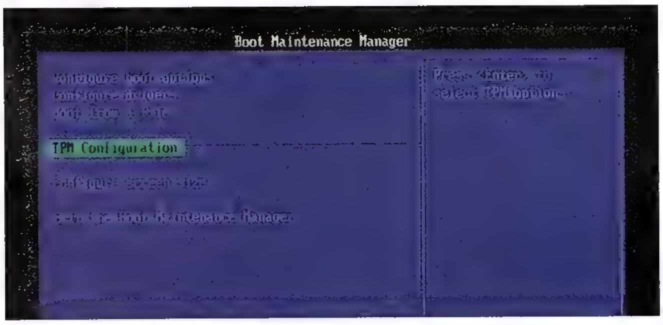
The upshot

For a lot of users, the lack of new security features in Windows 11 may be a disappointment. The main Windows 11 "innovation" is essentially that it's forcing people to use security systems that already existed, in particular those that use a TPM.

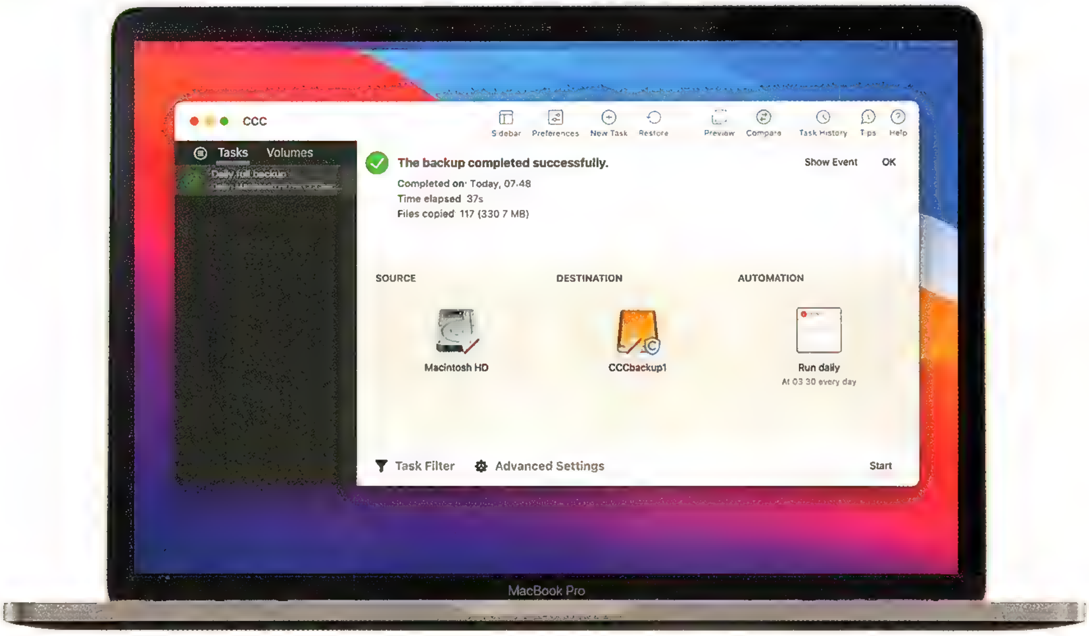
That is not, in itself, a bad thing. Many a system has been compromised because the home or business user did not properly apply security controls that they could have, but never bothered to, enable. Windows 11 may not be a security revolution, but we're going to say it's a good thing that Microsoft is going to enforce security more rigidly than it has in the past. ■

ENABLING THE TPM

In many cases, you may have a TPM but it's not enabled in firmware. In that case, you will need to log into your system's BIOS/UEFI interface and enable it in order to install Windows 11. The name is a little different across systems: look for TPM or fTPM settings, or "Intel Platform Trust Technology" or similar.



You may need to manually enable your TPM.


CCC
Sidebar
Preferences
New Task
Restore
Preview
Compare
Task History
Tips
Help
Tasks
Volumes
Daily full backup
Show Event
OK
Task Filter
Advanced Settings
Start
MacBook Pro

The backup completed successfully.
Completed on: Today, 07.48
Time elapsed: 37s
Files copied: 117 (330.7 MB)

SOURCE: Macintosh HD
DESTINATION: CCCbackup1
AUTOMATION: Run daily
At 03.30 every day

APPLE MAC

Make a copy of your Mac

Create a one-off copy or scheduled backup using Carbon Copy Cloner.

IT WILL TAKE
10 minutes

YOU WILL LEARN
To copy files so you can restore them

YOU'LL NEED
macOS 10.15 or later, external storage with sufficient free space, Carbon Copy Cloner 6

Whether or not Time Machine makes regular backups of your Mac, making a complete copy (a clone or mirror) of its contents is a good idea before you undertake to install macOS updates or upgrades. Carbon Copy Cloner 6 ($57.15, **bombich.com**) can make a one-off clone or regular backups in addition to, or instead of, Time Machine, and previous versions work for Mojave and earlier.

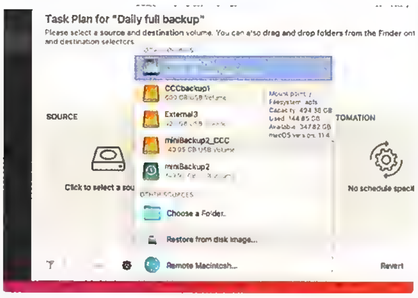
Catalina and Big Sur change the way that you restore from a clone. Rather than cloning back from the copy to your internal storage, it's better to install macOS then migrate from the copy, and that's the only way for M1 Macs.

That means you don't need to clone the System volume, which saves space, although CCC can still do that if you wish.

CCC has dozens of options. Here we show how to get the best from them, like excluding items best copied separately, and making snapshots for quick file recovery. Whatever you choose, check your clone works by restoring test items.
HOWARD OAKLEY

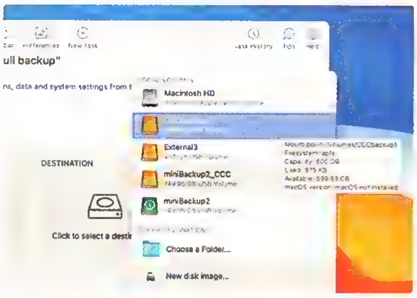
Catalina and Big Sur change the way that you restore from a clone. Rather than cloning back from the copy to your internal storage, it's better to install macOS then migrate from the copy, and that's the only way for M1 Macs.

HOW TO Clone your Mac the right way


Task Plan for "Daily full backup"
SOURCE
Click to select a sou
CCCbackup1
External3
miniBackup2_CCC
miniBackup2
Choose a Folder...
Restore from disk image...
Remote Macintosh...
TOMATION
No schedule speci
Revert

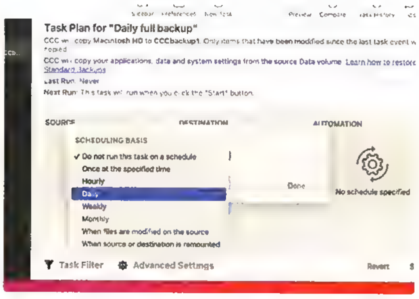
01 Set the source volume

In Carbon Copy Cloner, select Tasks in the sidebar and give the new, empty backup task a name. Click on the Source icon and select your Mac's startup disk, by default named Macintosh HD, to make it the source for your clone.


ull backup"
DESTINATION
Click to select a destir
Macintosh HD
External3
miniBackup2_CCC
miniBackup2
Choose a Folder...
New disk image...

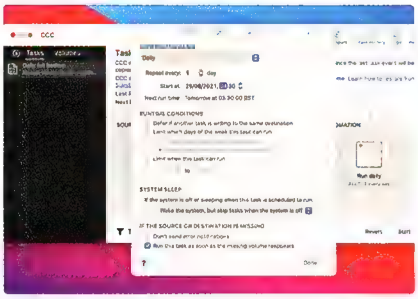
02 Set the destination

Note the used space on your source, and check the destination volume has sufficient free space to store that. Then click on the Destination icon and select the volume with enough free space to contain the clone.


Task Plan for "Daily full backup"
SOURCE
DESTINATION
AUTOMATION
SCHEDULING BASIS
✓ Do not run this task on a schedule
Once at the specified time
Hourly
Daily
Weekly
Monthly
When files are modified on the source
When source or destination is remounted
Done
No schedule specified
Task Filter
Advanced Settings
Revert

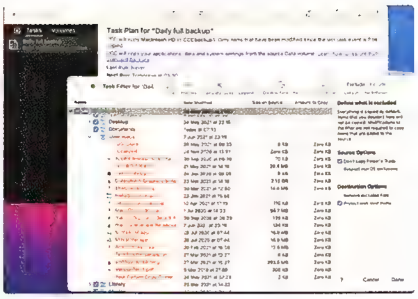
03 Set whether to repeat

Click on Automation to set the scheduling basis if you want this cloning to be repeated automatically. Normally a daily clone is best for backups, or when the disk is remounted for intermittently connected MacBooks.



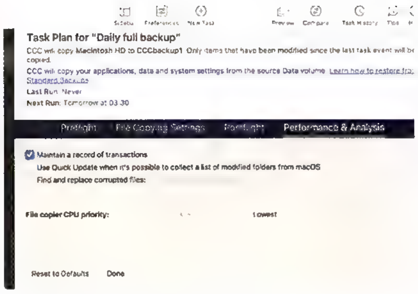
04 Set scheduling detail

If your Mac is left running overnight, it's a good idea to set the run time for when it's not in use. If it's going to be asleep, you can have the backup task wake the system, or leave it until later. You can also skip weekends.



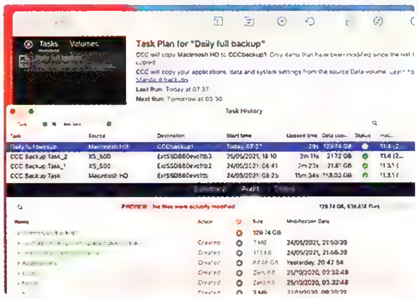
05 Set excluded items

Click Task Plan at the bottom of the main window to select items you don't want included in the clone. Consider keeping separate copies of huge files like Virtual Machines which change constantly when in use.



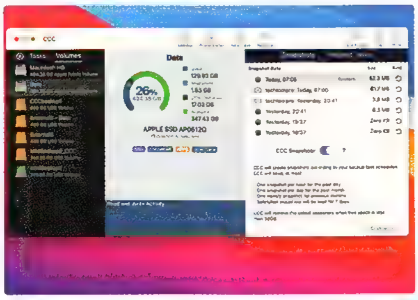
06 Set advanced options

CCC offers many options for the more advanced, such as running scripts before and after copying. If you want it to back up while you're using your Mac, you can now change the priority of its copying tasks here.



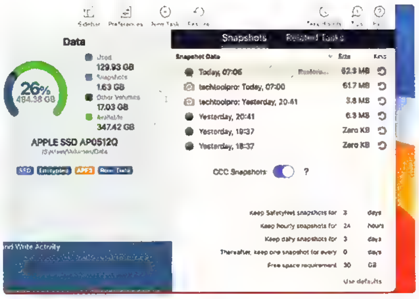
07 Check with a dry run

Before running the first clone, check whether copying will produce what you expect. Click on the Preview tool and CCC will do a dry run without copying any actual files, and forecast the exact size. Fix any errors now.



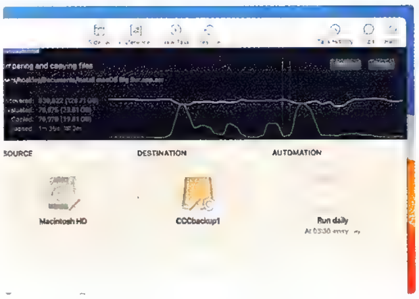
08 Set source snapshots

Consider making regular snapshots. Click Volumes in the sidebar and select the startup data volume named Macintosh HD – Data or just Data. Switch on for CCC to make a snapshot with each copy of that volume.



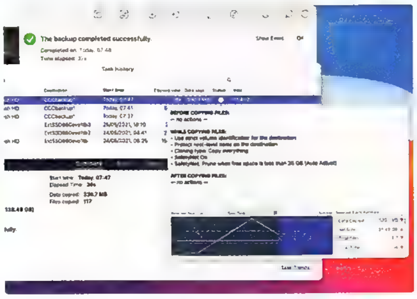
09 Snapshot retention

Most should find CCC's default snapshot retention policy ideal, as older snapshots can take large amounts of disk space. Click the Customize button to set your own policy if you wish, but monitor the space used.



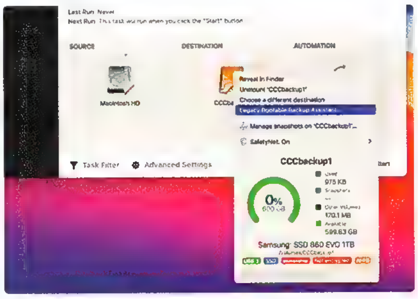
10 Clone that volume

When you've set everything up, control-click the task in the sidebar and use the Run Now command to make the first clone. CCC then shows its progress of the clone in graphical form, and an accurate estimate of time to finish.



11 Check task actions

When cloning has finished, click on Task History, select the completed task, and click on the Task Trends button to see a summary of actions. If the task is going to recur, click the Start button in the main window.



12 Optional System clone

If you want CCC to clone your System volume as well, before following step 7, set the Destination to make a full bootable backup by clicking on its icon and selecting the Legacy Bootable Backup Assistant command. ■

LINUX

Read RSS feeds direct from the terminal

Focus on what's important in the world and cut out all those cat meme distractions with Neil Mohr and a terminal-based text-only news reader.

What sort of world have we created? An open internet was supposed to be a bastion of human knowledge, where we could all share our thoughts, contribute to the advancement of all human knowledge and have an occasional game of *Quake*. What did we get instead? Facebook and a web of endless adverts and faux top-ten buying guides.

One of the standards that grew out of the early(ish) web was RSS (Really Simple Syndication) that was originally built into Nescape Navigator in 1999. It gave websites a way to announce updated content in a minimal way. Its popularity has come and gone, but RSS has stuck around even after Google Reader was killed off and the competing ATOM standard was launched.

An RSS feed offers a distraction-free way to obtain updates from your favourite website. If you combine this with the terminal then it means the latest news can be delivered directly to your favourite place to work.

We're going to take a look at NewsBoat. It's certainly not the only option, but it's currently actively developed, it's in most repos, there's a Snap (you lot stop moaning – Ed), it offers built-in HTML rendering, advanced filters, basic podcast support and loads more.

To install Newsboat on Ubuntu and Debian, type

```
$ sudo apt install newsboat
```

It's in both distro's repos, if you don't mind Snaps although it would be overkill for a terminal tool, then:

```
$ sudo snap install newsboat
```

If you want the latest bleeding-edge version then you can clone the Git, ensure you have all the build tools and dependencies, and then compile it from the source. Full details on how to do all that are in the online manual at **tinyurl.com/APC500RSS**.

Don't try and run it yet. There are no default RSS feeds and it'll kick out an error saying as much. We'll need to create a config file using:

```
$ nano ~/.newsboat/urls
```

At this point you'll want a few RSS feeds to add in. Perhaps we can help out with a few suggestions if you can't think of any offhand.

```
https://www.reddit.com/r/linux/.rss
https://lkml.org/rss.php
https://omgubuntu.co.uk/feed
https://www.raspberrypi.org/blog/feed/
https://www.anandtech.com/rss
```

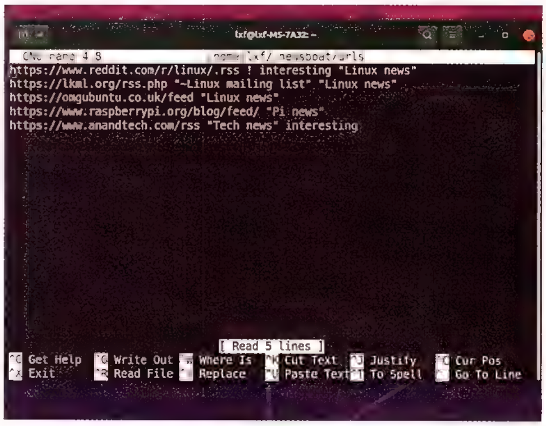
If you have a subscription RSS feed that requires a username and password to access the information, then the format looks like this:

```
https://username:password@hostname.domain.tld/feed.rss
```

If you're going to store passwords within the Newsboat configuration file it's best to ensure it can only be read by yourself with:

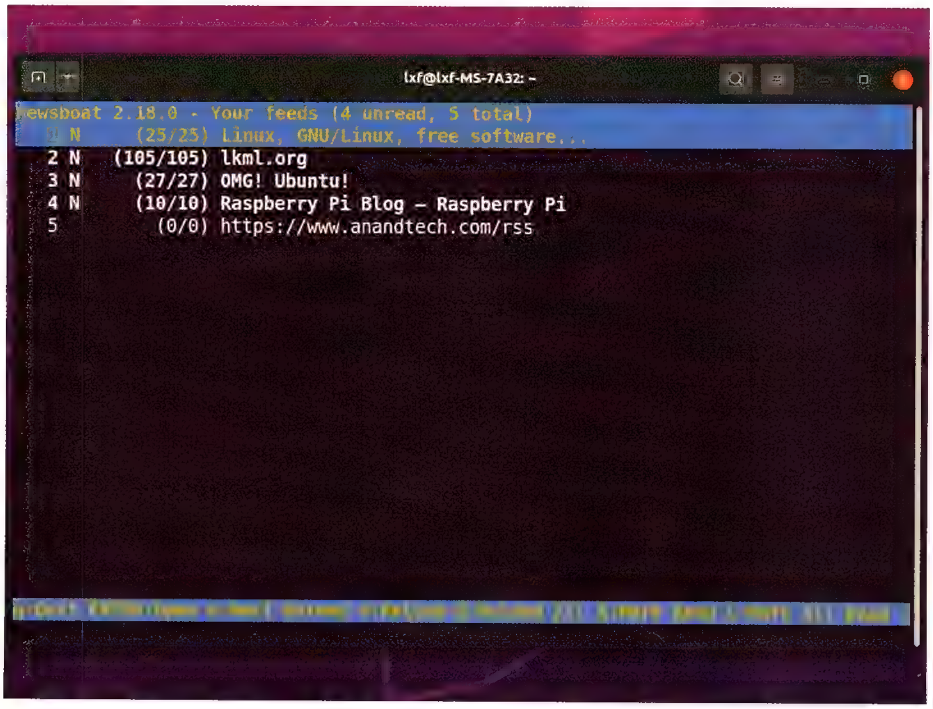
```
$ chmod u=rw,g=r,o= ~/.newsboat/urls
```

With a few feeds now configured start it with `newsboat -r`. Adding the `-r` forces Newsboat to refresh all the feeds. Why wouldn't you want this all the time? If you have a lot of feeds it's just wasting time and if you start Newsboat without the `-r` then once it's running you can individually refresh a feed by pressing r or refresh all feeds with R.



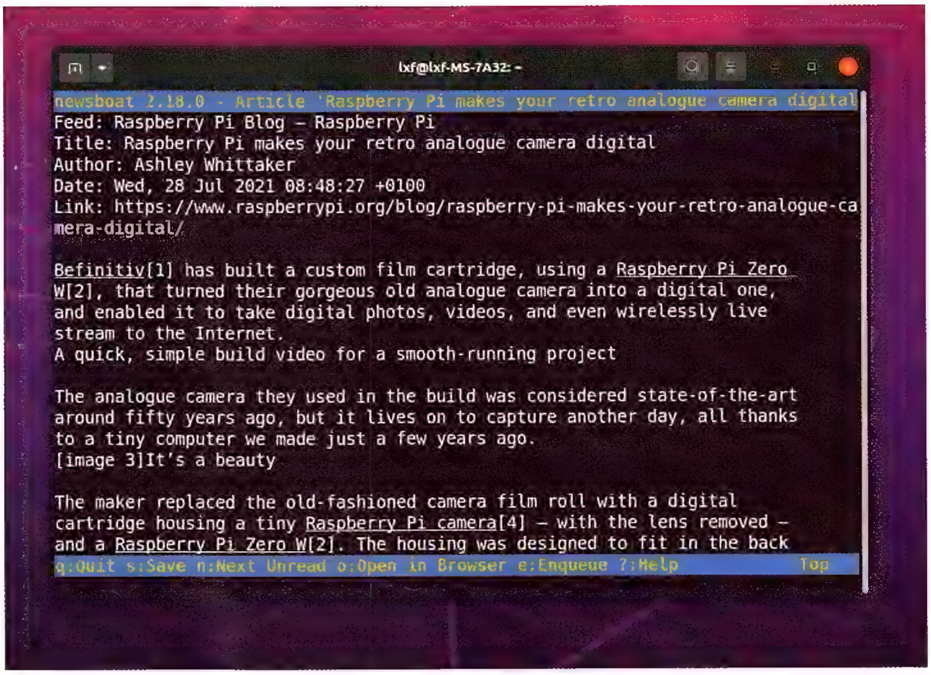
```
GNU nano 4.8                    /home/lxf/.newsboat/urls
https://www.reddit.com/r/linux/.rss ! interesting "Linux news"
https://lkml.org/rss.php "~Linux mailing list" "Linux news"
https://omgubuntu.co.uk/feed "Linux news"
https://www.raspberrypi.org/blog/feed/ "Pi news"
https://www.anandtech.com/rss "Tech news" interesting

                              [ Read 5 lines ]
^G Get Help   ^O Write Out  ^W Where Is   ^K Cut Text   ^J Justify    ^C Cur Pos
^X Exit       ^R Read File  ^\ Replace    ^U Paste Text ^T To Spell   ^_ Go To Line
```

A basic feed configuration showing how the tag system works with names and the Hide feature.



```
ewsboat 2.18.0 - Your feeds (4 unread, 5 total)
  1 N     (25/25) Linux, GNU/Linux, free software...
  2 N   (105/105) lkml.org
  3 N     (27/27) OMG! Ubuntu!
  4 N     (10/10) Raspberry Pi Blog – Raspberry Pi
  5         (0/0) https://www.anandtech.com/rss
```

Here's Newsboat in all its basic reading glory.



```
newsboat 2.18.0 - Article 'Raspberry Pi makes your retro analogue camera digital
Feed: Raspberry Pi Blog – Raspberry Pi
Title: Raspberry Pi makes your retro analogue camera digital
Author: Ashley Whittaker
Date: Wed, 28 Jul 2021 08:48:27 +0100
Link: https://www.raspberrypi.org/blog/raspberry-pi-makes-your-retro-analogue-ca
mera-digital/

Befinitiv[1] has built a custom film cartridge, using a Raspberry Pi Zero
W[2], that turned their gorgeous old analogue camera into a digital one,
and enabled it to take digital photos, videos, and even wirelessly live
stream to the Internet.
A quick, simple build video for a smooth-running project

The analogue camera they used in the build was considered state-of-the-art
around fifty years ago, but it lives on to capture another day, all thanks
to a tiny computer we made just a few years ago.
[image 3]It's a beauty

The maker replaced the old-fashioned camera film roll with a digital
cartridge housing a tiny Raspberry Pi camera[4] – with the lens removed –
and a Raspberry Pi Zero W[2]. The housing was designed to fit in the back
q:Quit s:Save n:Next Unread o:Open in Browser e:Enqueue ?:Help             Top
```

Most sites will only provide an overview of articles, but some will offer the entire text via RSS.

Basic navigation

Once you're in Newsboat and have actual articles to read, navigation is pretty obvious and quick:

up/down arrow keys – move the selection up and down by a single line

Enter – read the currently selected article

q – exit the current article/feed and then Newsboat

n – jumps you to the next unread article when pressed while inside an article

Home/End – jumps you to the start/end of either a list or an article itself

Pg up/Pg down – jumps you a single page up/down

? – lists all keyboard shortcuts

/ – opens the keyword search

Because the point of RSS feeds is simply to give you an outline of the article, if you want to read the full thing on the actual web site press o to open it in your default browser.

Adding tags

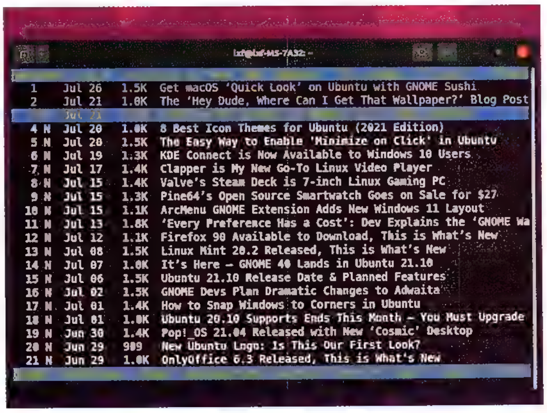
If you get really into RSS feeds then you can end up with a long list of them. To keep things organised it's recommended that you group feeds using one or more tags. So, for example, you could lump all the news sites into a "news" tag. It's no more complex than going back into the URL configuration file, leaving a space after the URL and adding the required tag name. If you want a longer tag that has spaces just enclose the tag name in "double quotes". You're able to use as many tags on a feed as you like – just separate them with a space.

When you now start Newsboat press the t key to view feeds organised by tags and use q to "quit" back to the normal feed view.

This simple tag system extends to renaming the feed name that's scrapped from the publisher. Again, after the URL give it any name that you'd like, starting with a ~ to show Newsboat that's the new name. Again, use double quotes if the name has spaces. If you want to hide a feed for some reason then use an ! after the URL – though it still appears in the tag view. You can also replace the ~ symbol with the ! as part of the name and it'll have the same effect.

RSS feeds are funny things. They certainly seemed to fall out of fashion at one point, but they're still around and can certainly help your scan and organise a heap of news and current events into a single, easy-to-access location. Newsboat is not the only option out there, but it's a quick and easy terminal option that's a worth a closer look. ■

> *Its popularity has come and gone, but RSS has stuck around even after Google Reader was killed off and the competing ATOM standard was launched.*



```
   1     Jul 26   1.5K  Get macOS 'Quick Look' on Ubuntu with GNOME Sushi
   2     Jul 21   1.0K  The 'Hey Dude, Where Can I Get That Wallpaper?' Blog Post
         Jul 21
   4 N   Jul 20   1.0K  8 Best Icon Themes for Ubuntu (2021 Edition)
   5 N   Jul 20   1.5K  The Easy Way to Enable 'Minimize on Click' in Ubuntu
   6 N   Jul 19   1.3K  KDE Connect is Now Available to Windows 10 Users
   7 N   Jul 17   1.4K  Clapper is My New Go-To Linux Video Player
   8 N   Jul 15   1.4K  Valve's Steam Deck is 7-inch Linux Gaming PC
   9 N   Jul 15   1.3K  Pine64's Open Source Smartwatch Goes on Sale for $27
  10 N   Jul 15   1.1K  ArcMenu GNOME Extension Adds New Windows 11 Layout
  11 N   Jul 13   1.8K  'Every Preference Has a Cost': Dev Explains the 'GNOME Wa
  12 N   Jul 12   1.1K  Firefox 90 Available to Download, This is What's New
  13 N   Jul 08   1.5K  Linux Mint 20.2 Released, This is What's New
  14 N   Jul 07   1.0K  It's Here – GNOME 40 Lands in Ubuntu 21.10
  15 N   Jul 06   1.5K  Ubuntu 21.10 Release Date & Planned Features
  16 N   Jul 02   1.5K  GNOME Devs Plan Dramatic Changes to Adwaita
  17 N   Jul 01   1.4K  How to Snap Windows to Corners in Ubuntu
  18 N   Jul 01   1.0K  Ubuntu 20.10 Supports Ends This Month – You Must Upgrade
  19 N   Jun 30   1.4K  Pop!_OS 21.04 Released with New 'Cosmic' Desktop
  20 N   Jun 29   909   New Ubuntu Logo: Is This Our First Look?
  21 N   Jun 29   1.0K  OnlyOffice 6.3 Released, This is What's New
```

The main article list is quick and easy to navigate.

RSS SERVICES

If you're already using RSS feeds via one of the many web services then good news – it's pretty easy to configure Newsboat to act as a newsreader for many of them. What's that, you ask? As you might have noticed, most RSS feeds are limited to a small number of current articles – 10 to 30 or so (the Linux kernel mailing list, or LKML, is unusual at 100+). So if you're not reading every day then it's easy to miss articles over time. Another option is that it means you can keep your read article list synchronised across multiple devices because they're all synchronising from the same online service.

Some online RSS services that are compatible are **theoldreader.com**, **newsblur.com**, **feedhq.org** and **bazqux.com**. There are additional self-hosted options supported, but this is something that's outside the scope of this article.

You should read the documentation for specific configuration of each service, but you'll need to add this to the configuration file:

```
urls-source "service name"
feedhq-url "https://serviceurl.
com/"
feedhq-login "username"
feedhq-password "password"
```

RASPBERRY PI

Drawing shapes with maths and code

Les Pounder shows how we can use simple maths to draw patterns and shapes, just like a classic childhood toy.

As a child I had Spirograph, and it was fascinating how coloured pencils and a rotating cog could create such wonderful patterns. Little did we know that years later we would be reproducing those same patterns with code. In this tutorial we shall use a little maths to generate coloured patterns in Scratch 3.

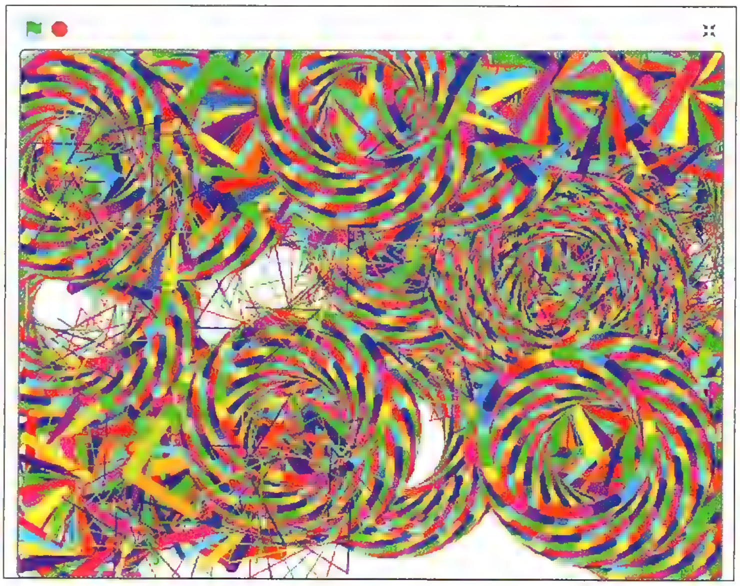
Scratch 3 should come pre-installed on your Raspberry Pi OS image, but just in case it is missing it can be installed from the main menu, under Preferences > Recommended Software. Scratch 3 is found in the Programming category; tick the box and click Apply to install. Once installed, Scratch 3 can be found in the main menu under Programming.

Open Scratch 3. On first start Scratch may take a little while to open. We're going to assume that you have an understanding of how to code with Scratch, but if not we covered the basics in previous issues. Before we write any new code we need to click the blue folder icon at the bottom left of the screen to load the Extensions menu. From there select Pen and a palette of new blocks is added to our code.

Draw a square

Next we need to go to My Blocks and click `Make a Block`. With this we can create our own Scratch blocks which will run a series of steps when the block is used. It works in a similar manner to Python's functions. Call the block 'Square' and click OK. A new red block `define Square` will appear in the coding area, and we will now write the code that will draw a square on the stage. Go to Pen and connect `pen down` to the `define Square` block. From Control, drag a `repeat 10` and connect it to the previous block. From Operators drag a `_ / __` block and drop it on top of the `10` of `repeat 10`.

Scratch 3 should come pre-installed on your Raspberry Pi OS image, but just in case it is missing it can be installed from the main menu, under Preferences > Recommended Software.



You too can create a psychedelic masterpiece with just a few blocks of Scratch code.

YOU'LL NEED THIS

A PC or a Raspberry Pi 3/4/400

The code for this project can be run online at **tinyurl.com/APC500scratch**.

QUICK TIP

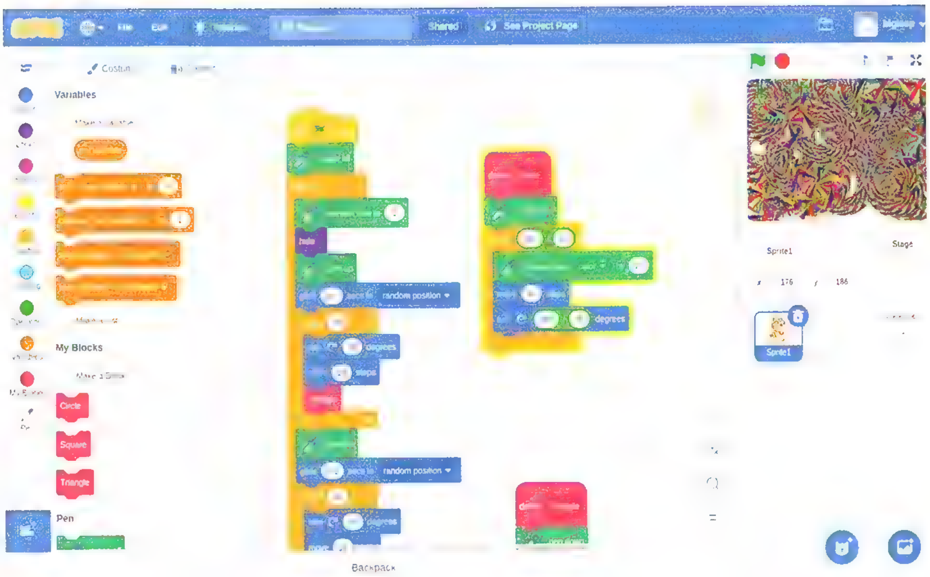
Using maths we can draw any shape in Scratch, but when we get to 20-sided shapes things get a little 'interesting' and we often run out of screen. So make sure your steps are smaller than 50, 10 is about right.

A square has four sides, all of equal length and each corner has a 90 degree turn. If we use a little maths we can determine that we need to divide 360 by 90 degrees, giving us the four times that the loop will iterate. Add the equation `360 / 90` to the blank spaces. Inside the loop, drag `change pen color by 10` to change the pen colour each time the loop iterates, creating a rainbow effect. Then drag `set pen size to 1` and connect it to the previous block. From Operators drag `pick random 1 to 10` and drop it on top of the `1` in `set pen size to 1`. This will randomly change the pen thickness as the loop iterates. From Motion drag `move 10 steps` and place it under the previous block, change the `10` to `50` so that we have a large square. Next drag `turn 15 degrees` from Motion and place it under the previous block. From Operators drag a `_ / __` block and drop it on top of the `turn 15 degrees` block. This time we need to turn the 360 / 4 degrees, 90 degrees. Type `360 / 4` into the operator block.

Create a circle

Create another new block via My Blocks and this time call your block `Circle` and click OK to create. A new red block `define Circle` will appear in the coding area, and our task now is to create a sequence of code that will draw a circle when we use the Circle block. From the Pen palette drag `pen down` and attach it to the Circle block. This will place the pen on the screen and enable us to draw. From Control drag a `repeat 10` and connect it to the previous block. From Operators drag a `_ / __` block and drop it on top of the `10` of `repeat 10`.

To draw a circle we need to do a little maths. A circle has 360 degrees, and to draw one circle



The code to create a forever sequence is rather simple, but there is quite a lot of it so make sure you visit our Scratch project to see it all.

we need to make a loop that iterates 36 times, each time rotating 10 degrees. To get 36 loops we need to divide 360 by 10 and the output of the equation will drive our loop to iterate. Inside the loop, drag **change pen color by 10** to change the pen colour each time the loop iterates, creating a rainbow effect. From Motion drag **move 10 steps** and place it under the previous block. Next drag **turn 15 degrees** from Motion and place it under the previous block. From Operators drag a **_ / __** block and drop it on top of the **turn 15 degrees** block. This time we need to turn the 360 / 36 degrees, 10 degrees. Type **360 / 36** into the operator block.

Draw a triangle

This is the trickiest of them all. In maths we are told that the internal angles of a triangle add up to 180 degrees, and that is still correct. But for Scratch we need to use external angles to draw the shape.

Create another new block via My Blocks and this time call your block **Triangle** and click OK to create.A new red block **define Triangle** will appear in the coding area. From the Pen palette drag **pen down** and attach it to the Triangle block. From Control drag a **repeat 10** and connect it to the previous block. From Operators drag a **_ / __** block and drop it on top of the **10** of **repeat 10**.

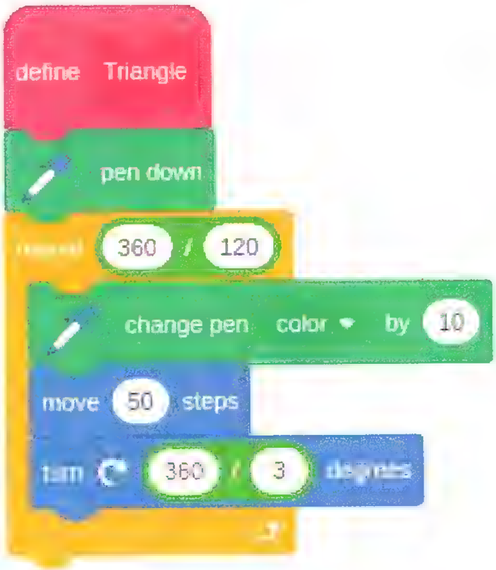
The maths this time is to work out the external angle. A triangle has three sides, so if we divide 360 / 3 we get 120 degrees. But remember this loop is the number of times it iterates to draw the sides, so our equation will be 360 / 120.

Inside the loop, drag **change pen color by 10** to change the pen colour each time the loop iterates, creating a rainbow effect. From Motion drag **move 10 steps** and place it under the previous block, change the **10** to a **50** for a larger triangle. Next drag **turn 15 degrees** from Motion and place it under the previous block. From Operators drag a **_ / __** block and drop it on top of the **turn 15 degrees** block. This time we need to turn the 360 / 3 degrees, 120 degrees. Type **360 / 3** into the operator block.

The sequence will use each of the shape blocks ina **forever** loop. From Events drag **When Green Flag Clicked** and place it in the coding area. From Pen connect **erase all** to clear the screen. From Control drag a **forever** loop and connect to the previous block. Inside the loop, from Pen drag **set pen size to 1** and then from Looks drag **hide** to hide the cat sprite. From Pen drag **pen up** and then from Motion drag **glide 1 secs to random position**, change the **1** to **0.1**. Now our invisible sprite will move around the stage without leaving any marks.

From Control drag **repeat 10** and change **10** to **24**. Inside this new loop, from motion drag **turn 15 degrees** and **move 10 steps** to move the sprite 24 times in a slow rotation. From My Blocks drag Triangle and connect it to the previous.

Lastly outside the **repeat 24** loop, but inside the main loop, drag **pen up** from Pen, and another **glide 0.1 secs to random position**. Click the green flag and watch as a spiral of triangles appears on the screen. Your next challenge is to try and have your Circle and Square blocks repeat the same sequence. ■



```
define Triangle
pen down
repeat (360) / (120)
    change pen color by (10)
    move (50) steps
    turn (360) / (3) degrees
```

The red Triangle block is a function that we can use to run all of the code within it.

TURTLE POWER

In this tutorial we drew patterns with code, but this is nothing new. Logo, a programming language from 1967, introduced the concept of 'turtle graphics', where a small cursor (the imaginary turtle) can be controlled using code. We can draw on the screen using simple commands, or use mathematical expressions to create elaborate art.

Turtle also featured a robot that connected to the computer and was programmed using the same commands. Place a pen in the turtle and you could draw the patterns for real. Logo and turtle have been seen in many systems over the years. Python has a built-in version of Turtle, a module that we can import and use in a similar manner. You can read more about Python turtle at **https://docs.python.org/3/library/turtle.html**.

Turtle is not just limited to the computer. Computer Science Unplugged has an offline version called Kidbots, where children have to write their own code to 'program' one of their friends. It teaches the basics of computer logic, geometry and how to write simple code. On a sunny day why not have a go in the classroom, or in your garden. See **https://csunplugged.org/en/topics/kidbots**.

HARDWARE

Playing it safe

When it comes to electrical safety, there's little room for error. Darren Yates looks at how problems can occur – and how to keep you and your family safe.

No matter your choice of tech, it's all fuelled by electricity and while it's the lifeblood of our modern world, it's also dangerous enough to kill – both you and your favourite gear. You don't need to panic, but you do need to take care and as we're into the summer months, now's a good time to brush up on some good electricity safety to protect you and yours.

DIY PC upgrading

Working on a PC upgrade can be one of the great joys in life. But to stay safe, always switch off and remove the power cable before you remove the case lid and start tinkering inside. First up, CPUs and RAM sticks are susceptible to what's known as 'electrostatic discharge' (ESD) damage. I can't remember experiencing this in all the years I've been building systems, but it pays to handle your sensitive silicon components with care. AMD has an FAQ on handling your components (**www.amd.com/en/support/kb/faq/cpu-100**), so it's worth a read. Intel also recommends you stand on an uncarpeted surface when working on your system (**intel.com.au/content/www/au/en/gaming/resources/how-to-build-a-gaming-pc.html**) .

However, one thing you should do is check that your home is fitted with an electrical safety switch or 'residual current device' (RCD). It monitors electrical current flow and instantly switches off if it detects an earth-leakage fault. New homes built from 1991 onwards must have one or more RCDs fitted, but it seems it's not yet a requirement on homes built before that. Nevertheless, rules for RCDs vary between states (including for rental properties), so check with appropriate state regulators for the rules in your area. RCDs and other electrical installation items must, by law, be installed by a licensed electrician, so leave this to the professionals.

One thing you should do is check that your home is fitted with an electrical safety switch or 'residual current device' (RCD). It monitors electrical current flow and instantly switches off if it detects an earth-leakage fault.

Only use a genuine charger with your device.

Before you open the PC case lid, always remove the power cable.

Phone chargers

Phone chargers are a must-have, but with the growing push from brands such as Samsung and Apple to no longer include them with new phones, you may need to buy you own replacements in future, rather than expect to see one with your next phone. However, you need to ensure any replacement charger you purchase is a genuine unit suitable for your device and purchase it from a reputable retailer because poor-quality chargers can be deadly. There are numerous reports online of people being tragically killed either by just touching faulty chargers plugged into mains power or using them with their device while listening with earphones.

Even if they don't kill you, there are also reports of electrical shock burns coming from poor-quality USB cables when users have accidentally laid down on them while plugged in and they've touched jewellery they're wearing. Personally, I won't use headphones with a mobile device while it's plugged into a phone charger.

Safe-charging your phone or laptop

Still, read enough web stories and it's easy to get spooked about how and when you should charge your mobile devices. The question of whether you can leave your devices charging overnight is one that comes up often and rarely gets a consistent answer. Some

N
CLIPSAL
4RCBE420/30
SAFETY SWITCH / CIRCUIT BREAKER
Regular test
0 OFF
0 OFF
0 OFF
50Hz
N
N

Left: Power boards can include surge protection, but how much is enough? **Right:** Residual current devices are important for safety, but don't appear in all homes.

say, 'yep, fine'. Others say 'definitely, no'. Samsung is reportedly in the 'no' corner, but this may be about maintaining battery life. If you do leave your device charging overnight, don't allow it to get too hot because heat is the enemy of batteries. Apple suggests removing your phone from its case first if it gets hot while charging inside it (**apple.com/batteries/maximizing-performance**).

What is easier to answer is making sure that when you do charge the device's battery, that you follow simple safety guidelines. These include making sure you have good airflow around the device – for example, don't leave your laptop charging on your bed or carpet. Make sure it's sitting on a clear, dry, flat surface with good airflow around it. If you're going away for the weekend, definitely don't leave the charger plugged into your device and the AC wall socket.

Electrical storms

Summer storms are a way of life in Australia, but they can also be the not-so-silent killer of tech. Just ask households in the Blue Mountains, west of Sydney. NBNCo was left with an expensive replacement bill earlier this year, having to swap out 10,000 NBN fibre-to-the-curb (FTTC) connection boxes found susceptible to lightning faults (**https://tinyurl.com/23m2cmu9**).

Now, you might be thinking 'no worries, NBN or insurance will cover any losses'. That might sound good in theory, but what compensation will return precious photos lost to lightning strikes? Call it overly cautious, but I always pull out the power cables for my PCs and laptops at the first rumble of an approaching storm. Safe is always better than sorry.

New Apple phones no longer include a charger, so buy only a genuine replacement.

But what about those multi-outlet power boards with built-in surge protection? Surge protectors are usually built around a device called a Metal-Oxide Varistor (MOV). Think of them like your health rating when gaming in first-person shooters – each hit you take knocks down your rating. MOVs work in a similar way – they can survive a few minor hits or one or two bigger ones, depending on the 'joule' rating. But whatever the case, they don't last indefinitely.

Many multi-outlet power boards will tell you a joule-rating (often as little as 150J) and may even include insurance cover for any gear plugged into the board damaged due to a surge. The problem is how many joules is enough? Is it 150? 200? 1000? It's a tough question to answer because it depends on, among other things, the proximity of the lightning strike to your home and the sensitivity of your gear to voltage spikes and surges. In other words, how long is a piece of string? Electricians can also install fuse-box surge protectors that can offer more protection.

Most free-standing dwellings will have one or more lightning or grounding rods, a thick rod often made of copper driven into the ground and connected to the electrical-earth near the fuse-box or panel. Its job is to redirect the electrical energy of a direct lightning strike to ground.

However, damage can occur from nearby strikes, so again, in my home, we don't rely on power board surge protectors; we unplug all PCs and laptops during a storm – call me 'Nervous Nellie'. If you're unsure, talk to your local electrician, who'll be able to point you in the right direction.

Take care

It's easy to take electricity for granted, but it's so important we don't. The cost of doing so could potentially be so much more than just losing your data. But by taking simple precautions and following good electrical safety, you're far less likely to run into trouble. ■

MACHINE OF THE MONTH

Thomson MO5 (1984)

A delightful French Sinclair ZX competitor from 1984, with John Knight.

You'll need this
http://dcmoto.free.fr
Minimum Pentium II 300 MHz and Windows 98.

This month, we head to France to explore a much-overlooked machine that can provide new experiences for hungry retro gamers. The Thomson MO5 is often referred to as "France's BBC Micro", and was the machine upon which many French schoolkids experienced their first taste of computing.

The MO5 uses unique hardware combinations with innovations well worth exploring, so let us take you on a brief tour of MO5 history, before showing you how to emulate this quirky machine.

Background

Thomson is a French sister company to General Electric, which began experimenting with computing in the 1970s. In the 1980s, Thomson started producing French microcomputers to capitalise on high import taxes, beginning with the T07 (1982) and TO7/70 (1984).

These were primarily business machines designed to take on the Apple II and Commodore 64. However, developments in Britain changed their priorities.

Sinclair's cut-price ZX Spectrum was mopping up the UK budget market, and schools there had adopted the BBC Micro en-masse. Thomson wanted to monopolise both of these markets in France and attempted to do so with the MO5.

MO5
UC 50.001 THOMSON
BASIC

Love it or hate it, the MO5 is definitely a stylish machine – especially its tape drive, which has a cool asymmetry to its design.

Launch

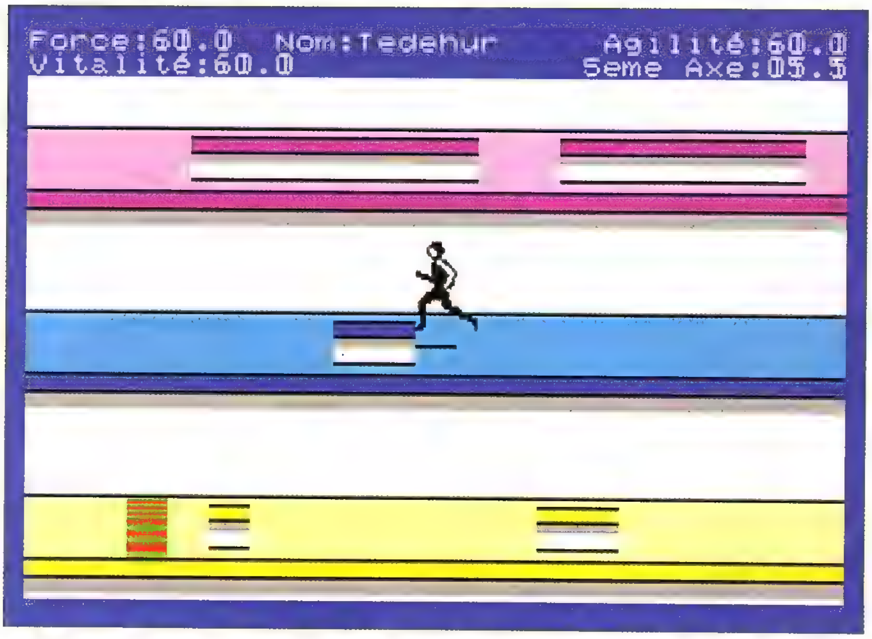
Released in June 1984, the MO5 was a cut-down version of the TO7/70 that packed 32KB of RAM, a Motorola 6809E CPU, and Microsoft BASIC (called MO5 BASIC) for 2390 Francs, around AU$550 at the time.

The MO5 has some peculiar hardware. Firstly, it used a Motorola 6809E CPU. The 6809 series had certain 16-bit capabilities and was more technically capable than its contemporaries, but was five or six times more expensive than a Z80 or 6502.

Sound-wise, the MO5 only gets a simple beeper. Rather than using a mouse, an optical pen came with the MO5 as standard. Thomson computers used proprietary parts, and add-ons were expensive. The MO5 was installed in French schools as part of the "Informatique pour tous" (Computing For All) plan. While the French government originally wanted to use the Apple Macintosh, Macs were simply too expensive, and an MO5 was a fifth of the price.

Although home users usually bought Thomson models with proper mechanical keyboards, schools were lumbered with cheaper models that used rubber keys.

Classrooms made use of the Thomson's special "Nanoréseau" network, where a standard PC would broadcast programs to a network of MO5 terminals. Students were taught BASIC and Logo, which was often used to control a robot tortoise.


Force:60.0 Nom:Tedehur Agilité:60.0
Vitalité:60.0 5eme Axe:05.5

Le 5eme Axe (1985, Loriciels) is probably the best game on the system, but you may need Google Translate on hand for the intro.

Games

Thomson probably spent and saved money in the wrong areas with the MO5, but it does provide retro gaming fans with something of a different dynamic. A lot of games feel slow, but the MO5 has a fascinating color palette as if someone crossed a ZX Spectrum, Commodore 64, and a Sega SC-3000.

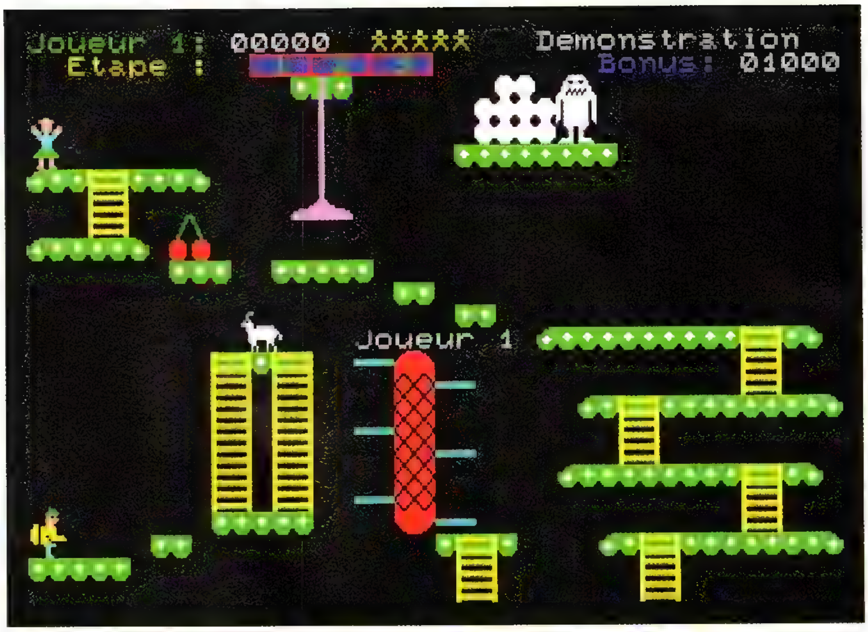
Of course, it's hard to find games you can play without the language barrier, but the following shouldn't be too taxing.

Choplifter (1982) is an arcade classic and a decent conversion, and *Wizball* (1988) and *Enduro Racer* (1988) are surprising, if over-ambitious, inclusions.

La Mine Aux Diamants (1986) is a great *Boulder Dash* clone for any fans

FRENCH GAMING CHEAT SHEET

joueur(s)	player(s)
charge/chargement	load/loading
appuyez	push
clavier	keyboard
manette	controller
tapez	type
étape	stage
niveau	level
langue	language



Yeti (1984, Loriciels) is a great *Donkey Kong* rip-off for the Thomson MO5 – and it's arguably better than the original.

wanting new levels, and *Androides* (1985) is a brutally difficult variation on *Lode Runner*. Fighting fans should try *Yie Ar Kung Fu II* (1986) and *Kung Fou* (1987).

Legacy

Although the MO5 sold well in France, that didn't translate to foreign markets. Improved models were introduced over the following two years, but were soon dropped in favor of 1986's MO6, which had 128KB of RAM and was backward-compatible with the MO5.

Unfortunately, Thomson's ubiquity in France was short-lived. Once economic conditions were favourable, Thomson was overtaken by the Amstrad CPC range (France was the Amstrad's most successful territory) and the 16-bit Atari ST. Thomson began selling IBM Compatible PCs in 1987 before leaving the computer market in 1989.

Emulation

While there are other Thomson emulators in existence, when it comes to the MO5, there is really only one choice: DCMOTO.

Although DCMOTO only comes with a Windows binary, Linux users needn't panic, it works perfectly well under Wine. Thomson emulator aside, the DCMOTO website also contains all the Thomson software you're looking for, as well as books, catalogs, documentation, and magazines.

To download the emulator, open the DCMOTO home page and click on the Emulator button. Most of the website is in French, but under the blue DCMOTO heading is a button labeled "Download". Click that and a ZIP file will download.

Extract the file and inside will be a Windows executable. You will need to open this manually each time, so you may want to make a desktop shortcut if you use DCMOTO often.

Getting started

When starting DCMOTO, there is a help screen in French. Click OK and you'll be taken to the main emulator screen.

The first things to do include changing the interface to English, then changing the Thomson model to an MO5.

Click the Options button in the main menu and a new window will appear, "DCMOTO paramètres".

At the left of the window, towards the middle, is a field called "Langue". Change this from Français to Anglais (English) and click the Appliquer (Apply) button.

Now choose the Thomson model from the Computer field around the top of the window.

By default, DCMOTO is set to TO9+. There are seven MO5 models to choose from; MO5 v1.1 works best with US keyboards.

Choose the 1.1 and click OK. A pop-up will appear saying a reboot is needed. That's just for DCMOTO, not your PC. Click OK.

vDCMOTO will now reset into an MO5 BASIC prompt, ready to be programmed or to load software.

Loading cartridges and disks

Whether you're loading a tape, disk, or cartridge, click "Removable media" in the main menu to get started.

Cartridges are the easiest medium to load. Just click the Load button next to the "Cartridge (.rom)" field, choose your file, click Open, and your game will load.

While we couldn't find a foolproof way of getting disks to load, we did find a decent method to get your game started, and thankfully MO5 disk software is quite rare.

First, you need to enable the external disk drive. Click Options in the main menu, and in the settings window is a field called "Extern controller". Click the option "CD90-351 (3.5in)" then choose OK. Now click "Removable media" from the main menu and press Load to choose a disk image file. Browse for your disk file, then click Open.

Reset the MO5 by clicking File > Hard reset. With any luck, your disk will boot itself.

Loading tapes

Tape software is by far the most common format, but getting tapes to load is something of a lottery: so you will probably need to try several commands to load a program.

Start by choosing a tape image file from the Removable media window, then click OK.

Now you need to try entering a few BASIC load commands – remember to press Enter after each of these commands.

The easiest method is to try just entering LOAD by itself. If you're left with an "OK" message and a blinking cursor, enter **RUN**.

If that doesn't work, try typing:

```
LOADM"",,R
```

Or in the case of *Le 5eme Axe*, simply:

```
LOADM
```

If you're using a US keyboard, you will need to press **Shift-2** to type the " character.

If none of these commands work, try typing: `LOADM "CASS:",R`

On our keyboard, we entered the : symbol by pressing **Shift-\**, which should be above the Enter key. If you run into any further problems entering characters, you can bring up a French virtual keyboard by clicking Tools > Keyboard.

Lastly, if any program needs a strange command to load, it's worth looking at the filename, which often contains the required load command. ■

grand theft auto

GRAND THEFT AUTO: THE TRILOGY IS COMING THIS YEAR

Rockstar gives the original PS2 series a new coat of paint.

Grand Theft Auto 5 is just over eight years old this year, but it's still Rockstar's biggest focus – it's even getting a re-release in 2022 for new-gen consoles. As anticipation rises for morsels of *GTA 6* info, here's something of a rarity nowadays: Rockstar has announced a new game.

It's actually three, and they're reissues of the first three *Grand Theft Auto* 3D games (ie, not the first two top down affairs). The reissue treatment will come to *GTA 3*, *GTA: Vice City* and *GTA: San Andreas*, and all will feature "across-the-board upgrades including graphical improvements and modern gameplay enhancements," while retaining "the classic look and feel" of the original versions. How that balance will be achieved is yet to be seen, because Rockstar has yet to show footage, and outside of a vague 2021 release window it's unknown when they'll hit PC.

EA SPORTS
FIFA 21
FIFA

FIFA MAY BE NO MORE AS EA TRADEMARKS 'EA SPORTS FC'

A new era for the market dominating soccer sim.

After 27 years of paying FIFA for the naming rights to its soccer game, publisher Electronic Arts has apparently had enough. Last month EA Sports general manager Cam Weber wrote that the company was "exploring the idea of renaming our global EA Sports football games," which seemed inconclusive, until a trademark appeared in the following days for 'EA Sports FC'.

It's probably a wise move: EA is likely spending quite a bit for the *FIFA* branding, even though its own EA Sports branding probably has better awareness among videogame consumers. The change hasn't been made 100 percent official, but don't be surprised if *FIFA 22* is the last with that naming convention.

With *New World's* success, Amazon is getting cocky about games

Jeff Bezos is happy.

Amazon's first serious foray into videogames was a disaster, with the PvP first-person shooter *Crucible* only lasting a matter of months before being pulled. But the megacorp's new MMO *New World* is faring much better: it's continued to dominate the Steam charts since its early October launch, and naturally, this is making Amazon executives very happy.

"After many failures and setbacks in gaming we have a success," former CEO and current executive chairman Jeff Bezos tweeted in the days after launch. "So proud of the team for the persistence. View setbacks as helpful obstacles that drive learning. Whatever your goals are, don't give up no matter how hard it gets."

The company's current CEO Andy Jassy is equally pleased, though a little less equinaminous. "There were a lot of articles written, people saying things like 'Amazon knows how to build everything but games, why can't they build games?'" Jassy said in an interview with Bloomberg. "It takes a few before you find a hit, or several, but they didn't lose their resolve."

The game launched well, sure, but as a live service MMO, *New World* will need close attention and high maintenance if it wants to endure as the likes of *World of Warcraft* or *Final Fantasy 14* have.

UBISOFT ANNOUNCES YET ANOTHER FREE-TO-PLAY SHOOTER

They're coming thick and fast, this time with Ghost Recon branding.

Ubisoft is throwing live service shooters at the wall to see what sticks: in May it announced *The Division Heartland*, a free-to-play shooter set for release in 2022. In June it announced *Tom Clancy's XDefiant*, a free-to-play shooter for PC and consoles coming later this year. Now it has announced *Ghost Recon Frontline*, another Tom Clancy-adjacent free-to-play shooter, which entered beta last month.

It's an interesting approach by the French company, which didn't have much success with its first and most high-profile free-to-play battle royale, *Hyper Scape*. On the bright side, Ubisoft's *Rainbow Six Siege* continues to be a popular competitive game, so there's every chance one of these (but probably not all of them) will stick.

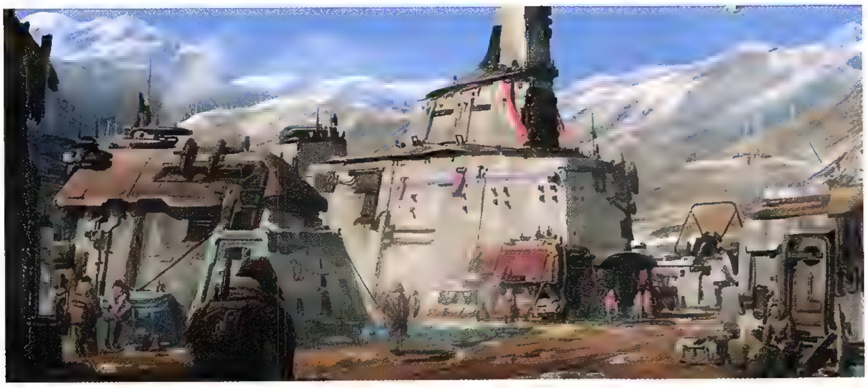
Bungie pledges to make *Destiny* 2 and its future games more accessible

Destiny 2 guns like scouts and sidearms may get a full-auto option, for starters.

Bungie has founded a dedicated accessibility initiative to oversee work that will make *Destiny 2* and its future games more accessible. The studio outlined its ambitions for Accessibility at Bungie, a new internal Inclusion Club, in a recent blog post. "Its mission is to educate everyone in the company on identifying barriers, to improve workplace accessibility, to make material improvements to the playability of Bungie's games, and to partner with organisations within the gaming industry who are dedicated to game accessibility," it explains.

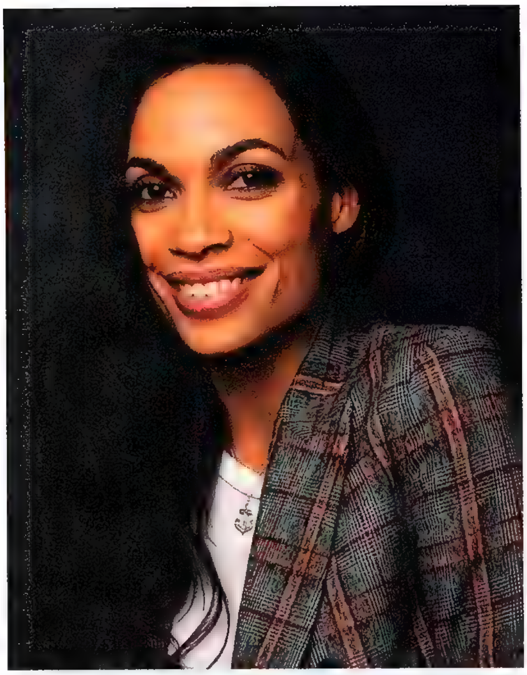
Player support specialist Drew Tucker will help lead the studio's accessibility push. He's joined by designer Jonathan Barbeau, senior designer Robert Schuster, and other members of Bungie and the *Destiny 2* team.

"In my time here, I've seen a lot of players describe mental health issues they are experiencing and are trying to seek help," Tucker says. "We have procedures in place to guide them toward help, but I've always wanted to do more."



STARFIELD HAS MORE THAN TWICE AS MANY DIALOGUE LINES AS *SKYRIM*

During the presentation last month at the Tokyo Games Show, *Starfield* creative director Todd Howard briefly appeared to reveal that the RPG would have a full Japanese voiceover, while also mentioning that *Starfield* boasts well over 150,000 lines of dialog (thanks, Nibel). This puts *Starfield*'s voice line count well above both *Fallout 4* and *Skyrim*.



DYING LIGHT 2 CASTS ROSARIO DAWSON AS LAWAN, YOUR BEST FRIEND OR WORST ENEMY

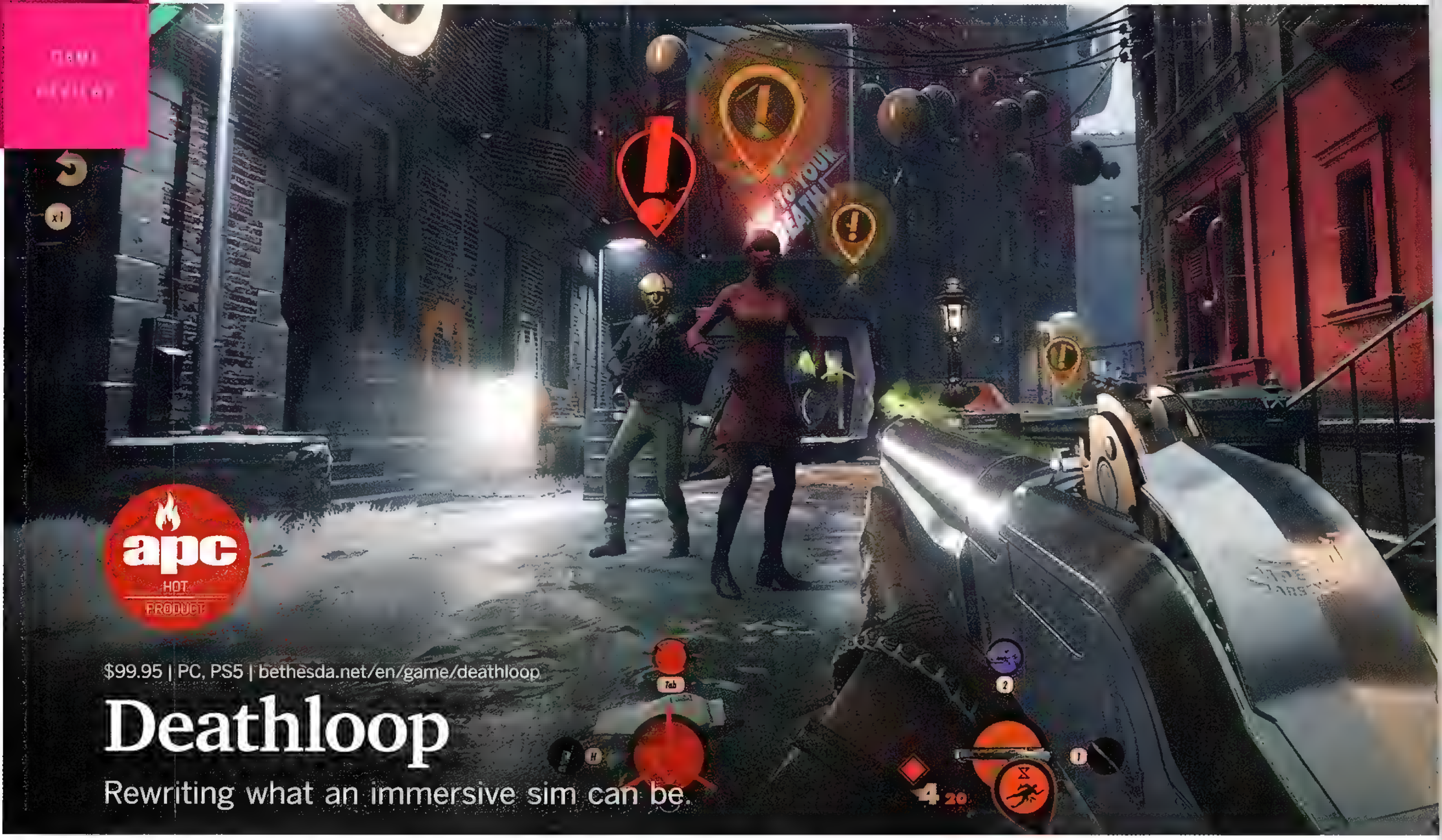
Dying Light 2 will star Rosario Dawson as Lawan, a fellow fighter and survivor whose path will be shaped by your own. Her character will be strongly influenced by the character's actions: depending on your choices, she could become driven solely by bloodlust and her personal quest for vengeance, or she could become a night runner who dedicates her life to helping other people.

BATTLEFIELD 2042 HAS A NEW COMMUNITY CHARTER THAT GOES BEYOND THE GAME

Complete with in-game consequences.

Battlefield 2042 just got an official charter that players will be expected to abide by in the game and surrounding communities. EA and DICE posted the Battlefield Community Charter on the official site for *Battlefield 2042*, laying out a set of plain-language rules and expectations for players. Failure to follow them could result in consequences ranging from temporary account restrictions to permanent termination of your EA account (as well as any other EA accounts you may happen to hold).

The good news for players who want to stay out of trouble is that they're all pretty common sense: treat other players how you'd like to be treated – aside from shooting at them in-game, anyway – avoid using cheats or exploits, don't share anything inappropriate, and don't participate in or encourage any illegal activities. The charter is broadly worded so as not to just apply to in-game behaviour: what you do in *Battlefield*-related spaces could also have consequences for your access to the game itself. ■



$99.95 | PC, PS5 | bethesda.net/en/game/deathloop

Deathloop

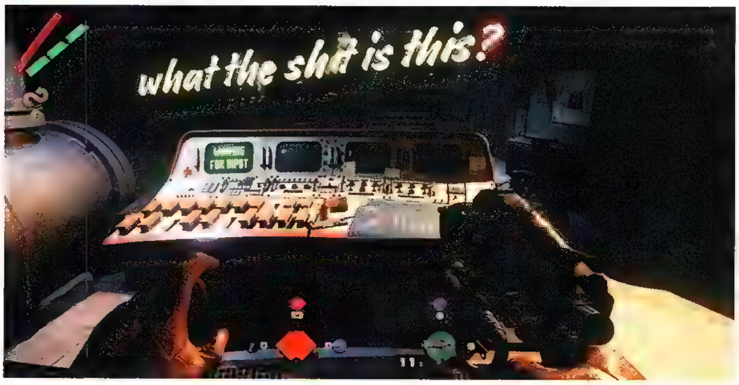
Rewriting what an immersive sim can be.

Deathloop is all about what happens when things don't go to plan; about panic and improvisation; about learning from a mistake, and taking those lessons forward. Trapped in a time loop, it doesn't matter if you botch your way through combat encounter after combat encounter – it doesn't even matter if you die and get kicked back to the beginning of the day. All that matters is that, in doing so, you gained some information that will help you the next time around.

Information is how you find and kill the Visionaries that act as the bosses of the island. There are eight in total, and your job as the amnesiac Colt Vahn is to take them all out in a single day in order to break the loop. Your problem is that the day is split into four chunks – morning, noon, afternoon, and evening – and you can only visit one of the island's four areas during each period. The Visionaries only appear in certain locations at certain times of the day, and at first it doesn't seem possible to kill them all before the loop resets and your work is undone.

As you dig into the lives of your hit list, though, you'll uncover new ways to manipulate them. This is the bulk of the game, and your progress is tracked and updated as each new lead is uncovered. Colt is one of only two people whose memory remains intact when the day loops, which means his targets' behaviour remains consistent, and thus repeatable. It's immensely satisfying as the pieces start falling into place – as you see the consequences of your actions, and start filling out your itinerary in preparation for that perfect day.

You can tell that *Wolfenstein*'s MachineGames played a role in *Deathloop*'s development. The guns are chunky, powerful, and cacophonously loud. That said, the increased focus on violence and combat does accentuate some weaknesses in the AI. It can be easy to cheese combat encounters, using corners or doors to funnel enemies into a killzone. But between the guns, the tools, the more combat-focused slabs, and the free respawns, it just feels more exciting to embrace the chaos and wade into the mess.



A masterfully crafted world of puzzles and mysteries.

INFUSE GEAR
SACRIFICE 13 ITEMS
CANCEL

Top: Stealth is fine, sure, but sometimes a shotgun frenzy is called for.
Above: Every part of *Deathloop* is beautifully designed.

For the first few hours of *Deathloop*, I was more interested in it as Arkane's response to *Dishonored* – a series that I love. I was enjoying myself, and looking forward to uncovering the mysteries of the island, but was more intrigued by what Arkane was saying about the genre as a whole, and about the way people played its previous games.

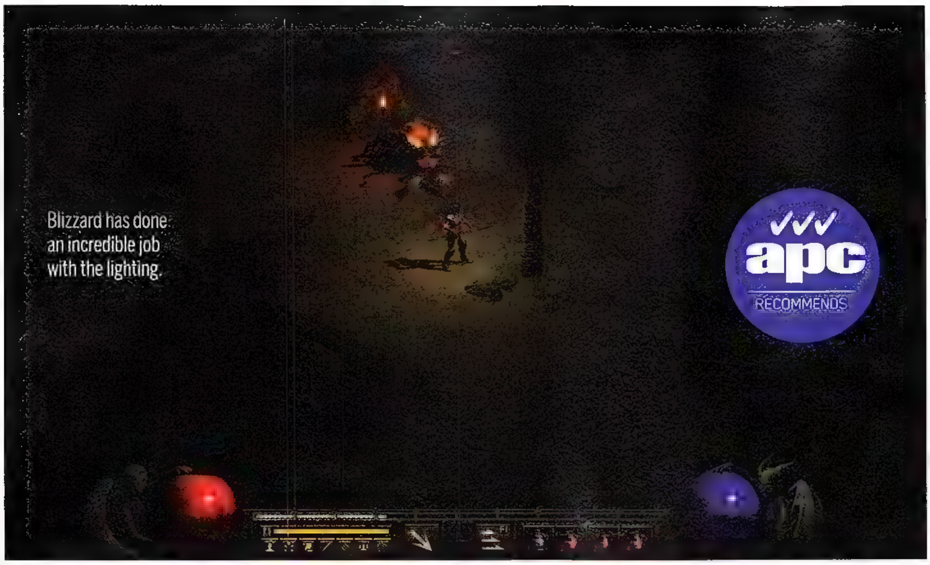
After around 25 hours, I may have completed the story, but I'm still not done: I want to complete the remaining puzzles to see what new weapons and upgrades are out there, and learn how they can help my fight against Julianna in the future.

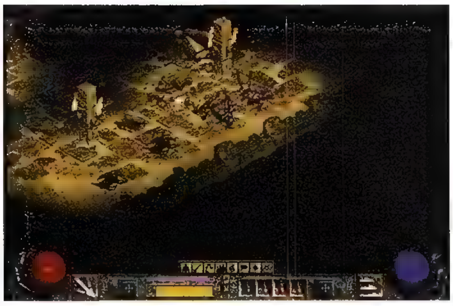
■

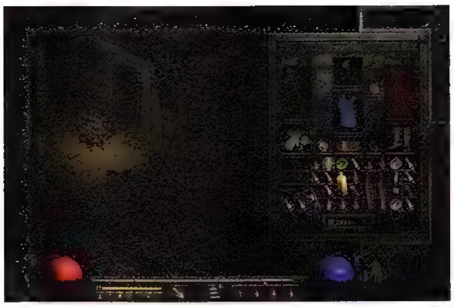
An entertaining stealth shooter in its own right, but it's the multiplayer invasions that make *Deathloop* sing.

Phil Savage

★★★★½


Blizzard has done an incredible job with the lighting.





$69.95 | PC, PS5, XB1 | diablo2.blizzard.com/en-us

Diablo II: Resurrected

A proud love letter to one of the greatest RPGs of all time.

Diablo II: Resurrected moves at two speeds: You are either carving through swathes of undead with impunity, or you're navigating each fork in the road with taut reluctance, nursing the small puddle of red in the bottom left corner of the screen. Action-RPGs are a known quantity in 2021, so what I most appreciated about my return to Blizzard's classic was the way it made me fear the dark again, with no friendly checkpoints to save me.

Diablo II came out in 2000, and *Resurrected* represents the first new game in the franchise since the release of its sequel in 2012. The basics are all in place. You will take control of a lonely warrior – picked from one of seven different classes – who are condemned to wander Blizzard's arid, Old Testament wasteland. The game is divided into five different acts, each with their own hub that sprawls out into a procedurally generated universe. Step into the wilds and complete quests, plunder chests, and click zillions of cloven-hooved demons to death. *Diablo II* took over countless lives at the turn of the millennium, and it's still deeply compelling in 2021.

Blizzard has reupholstered much of their back-catalogue to varying degrees of success, but there is a tender attention to detail in this new version of *Diablo II* that exceeds what's available in those other efforts. At any moment, players can tap the G key to shift back into the original art and witness all of the airbrushing. I was often surprised at what I found. Streams of putrid water run through the sewers of Lut Gholein that simply didn't exist in the game files back in 2000. It's amazing what is possible, when everything isn't rendered in 800 by 600.

This is not a video game designed to inaugurate a fresh generation of Tristam survivors – that duty is surely left to the forthcoming *Diablo IV*. Instead, the players gathered here have all been playing *Diablo II* for years, and now they have a prettier, smoother, and slightly less finicky version to enjoy.

■

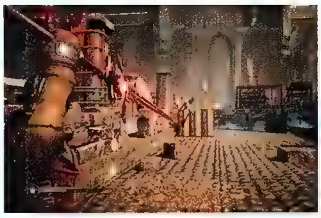
Combines a beautiful new look and some smart innovations to deliver a great take on a classic.

Luke Winkie

★★★★☆

Above left: There's a comforting familiarity about being in a Diablo dungeon.

Above: Inventory management has seen a complete overhaul in how it functions.



Free | PC | bit.ly/BloodSpear

BLOOD SPEAR

Skewering undead with a chatty stick.

Blood Spear is a student project that puts its own spin on the *Souls*-like formula. Gone are the souls, the bonfires, or any sense of character advancement. All that remains is an undead medieval world, and the titular spear: a sentient weapon that thirsts for blood.

It's not entirely clear if you play as the *Blood Spear*, or the poor dead knight it has possessed. Either way, the pair are soon up and running through a few attractive environments, killing undead and floating eyeballs on their way to the boss. *Blood Spear* took me about an hour, feeling like a slice of a bigger action game. However, there was enough space for the spear to be given a proper workout.

There are no other weapons here, and no equipment or items to pick up. Instead, you fling the *Blood Spear*, while occasionally dodging enemies and incoming missiles. The novel combat system is well-implemented, and its eyeball protagonist is a fascinating little critter. Delay your latest run of *Dark Souls* for an hour and give this striking, polished *Souls*-like a play.

■

A brief, linear *Souls*-like that packs a lot of cool ideas into just an hour.

Tom Sykes

★★★☆☆

Free | PC | Steam

ALPACA STACKA

Stacking chicks in a 3D platformer.

Paz the alpaca might be the star of this 3D platformer, but it's Streusel who makes it: the jealous squirrel who kicks it off by opening a gate and letting loose five adorable chicks. He's the heart of a five-minute game that feels remarkably full, despite its brief length, and that has much to do with Streusel's funny, redemptive journey.

After the chick-loosing incident, Paz volunteers to find them, roaming the island and following clues to each of the birds. It's not very complicated, and anyway the island is so small you're going to find them all eventually, whether it takes you five minutes or ten.

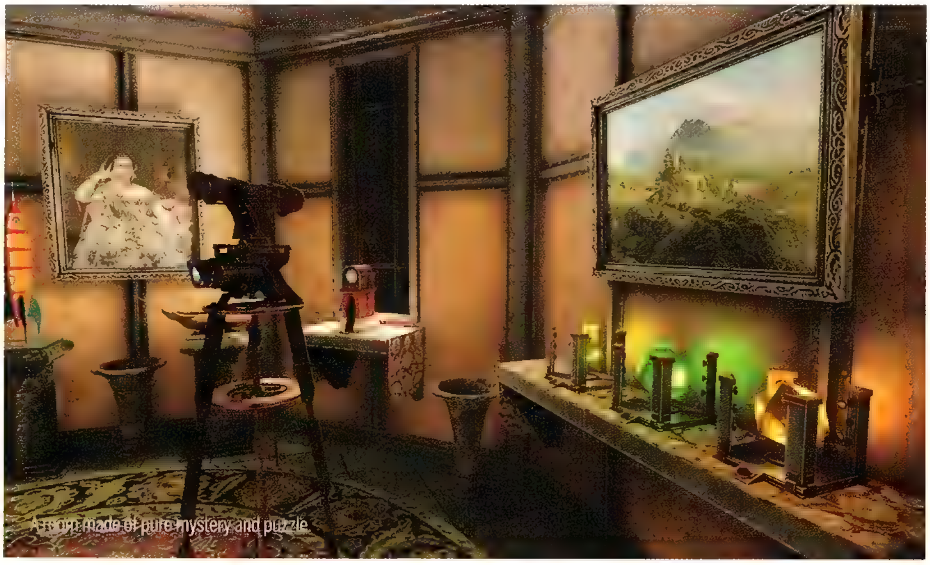
But as you explore, Streusel rears his head. Or rather, his bushy tail, which frequently emerges from nearby shrubbery as you jump about. Obviously he's following you, and doing a terrible job of hiding. Get too close and Streusel will hurriedly retrieve his tail. It's a lovely bit of programming that reminds you what the game is about: a jealous squirrel who feels excluded, and lashes out.

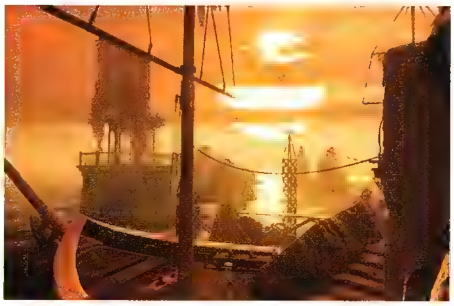
■

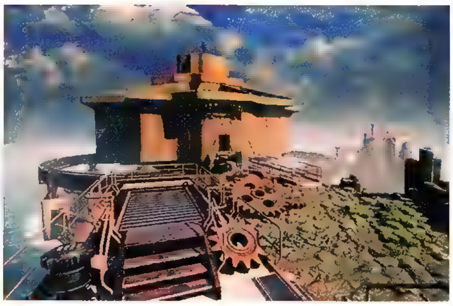
A playable picture book, complete with a feel-good ending

Tom Sykes

★★★⯪☆







Above: It's still as pretty as a painting.
Above right: We're sensing a theme... something to do with gears.

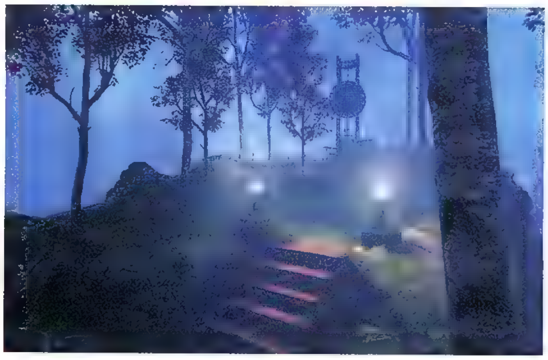
$42.95 | PC, Mac | cyan.com/games/myst

Myst

The classic puzzle game gets a modern update.

It's a little weird to be back in *Myst* in 2021, after all this time. Cyan Worlds has completely remade the game (again, following *realMyst* and *realMyst: Masterpiece Edition*). And this new 3D *Myst* works on both desktop and in VR, so I got to spend time actually (virtually) walking around in it. As a remake, *Myst* is a faithful one, but maybe a bit too faithful. Cyan Worlds says it's a "reimagined" *Myst*, but while it's far more modern-looking it's still almost exactly the same game. *Myst*, no matter how it looks in 2021, feels pretty outdated.

It is nice to be able to actually walk through the world this time, and for a while it's novel experiencing a familiar place in a new way, wandering from puzzle to puzzle rather than just clicking on static images when I want to move around. At the same time it highlights how even a freshly rebuilt game can still feel a bit out of date, because *Myst* is a lovely place, but it's not a big place. Everything on the islands is just a few steps away from everything else.



Puzzles are just the same as they were in the original, though you can randomise them if you want to play again with a new challenge. As they did in 1993, the puzzles can be fairly straightforward, punishingly difficult, or somewhere in between.

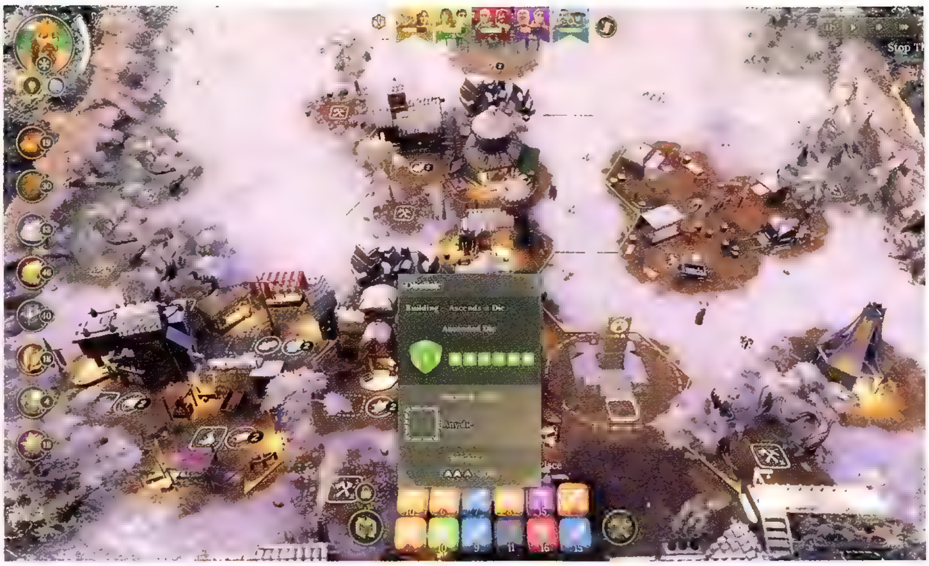
Even with this modern facelift, the world of *Myst* remains mostly static, and even in 3D it still feels more like a painting of a place than an actual place. It's nice to revisit *Myst* after all these years, but even in the 3D the classic puzzle slideshow still feels like a series of pretty pictures to be looked at rather than a real location to visit. If you've got an itch to revisit *Myst*, this is the version I'd suggest trying, as long as you're not expecting something altogether different than the 1993 original.

■

This modern remake gives the classic game a lovely coat of paint, but doesn't stop it from feeling outdated.

Chris Livingston

★★★☆☆



Above left: You can 'ascend' dice, and use them in future games. **Above:** Resources are plentiful, but finite.

$24.95 | PC, Switch | dicelegacy.com

Dice Legacy

In this city builder you win or you die.

Don't let *Dice Legacy* deceive you, as it did me. It's not a chill city builder, with a couple of quirky features and nascent roguelike elements. No, it's a pitched battle for survival, pitting your dicey tribe against the winter and, eventually, a rival settlement. You're not (just) building a cute medieval town by plonking dice down on a dizzying ringworld planet – you're building a machine to take your enemies, The Others, down.

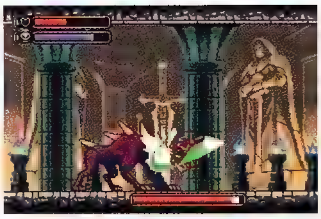
You'd be forgiven for thinking otherwise, given how sedately *Dice Legacy* starts. Parking your ship by a curved landmass, you soon go about the usual colony stuff: building a house and assigning workers to essential tasks. Food needs to be hunted, wood gathered and so on. But here your people are represented by colourful dice.

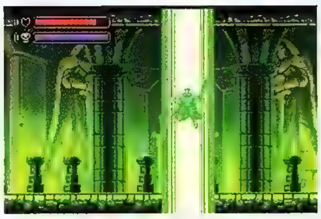
Exploiting the land involves matching die faces to the various icons in the environment. The Tool icon is found by forests, mines, meadows, and hunting lodges, and extraction is as simple as dropping a die with the same icon atop each resource. When the timer runs out, the die becomes exhausted, requiring a re-roll before it can be used again.

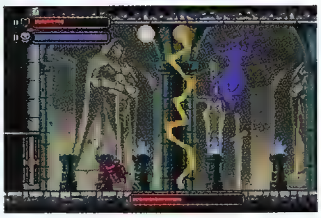
The tension at the heart of *Dice Legacy* is that its dice have durability. This is lowered every time you roll and they, er, die if it ever drops below zero. You're forever weighing the need to re-roll against the need to preserve durability, which can only be restored by plopping a die in the cookhouse with a bit of food.But there are other hazards too. Dice can be wounded and killed in combat, or stricken with an infectious plague. And, when winter rolls around, they can be frozen, rendering them useless until you heal them, or the season ends.

There's always been some overlap between city builders and real-time strategy games, but *Dice Legacy* carves an awkward niche in the middle. Yes, it's a game about building a colony, but your every effort should be directed towards overcoming its cliff-like final battle.

A smart and peculiar city builder that ends in a gruelling uphill battle against a tough rival city.
Tom Sykes
★★★☆☆







Free | PC, browser
r-goulart.itch.io

HEXBLADE

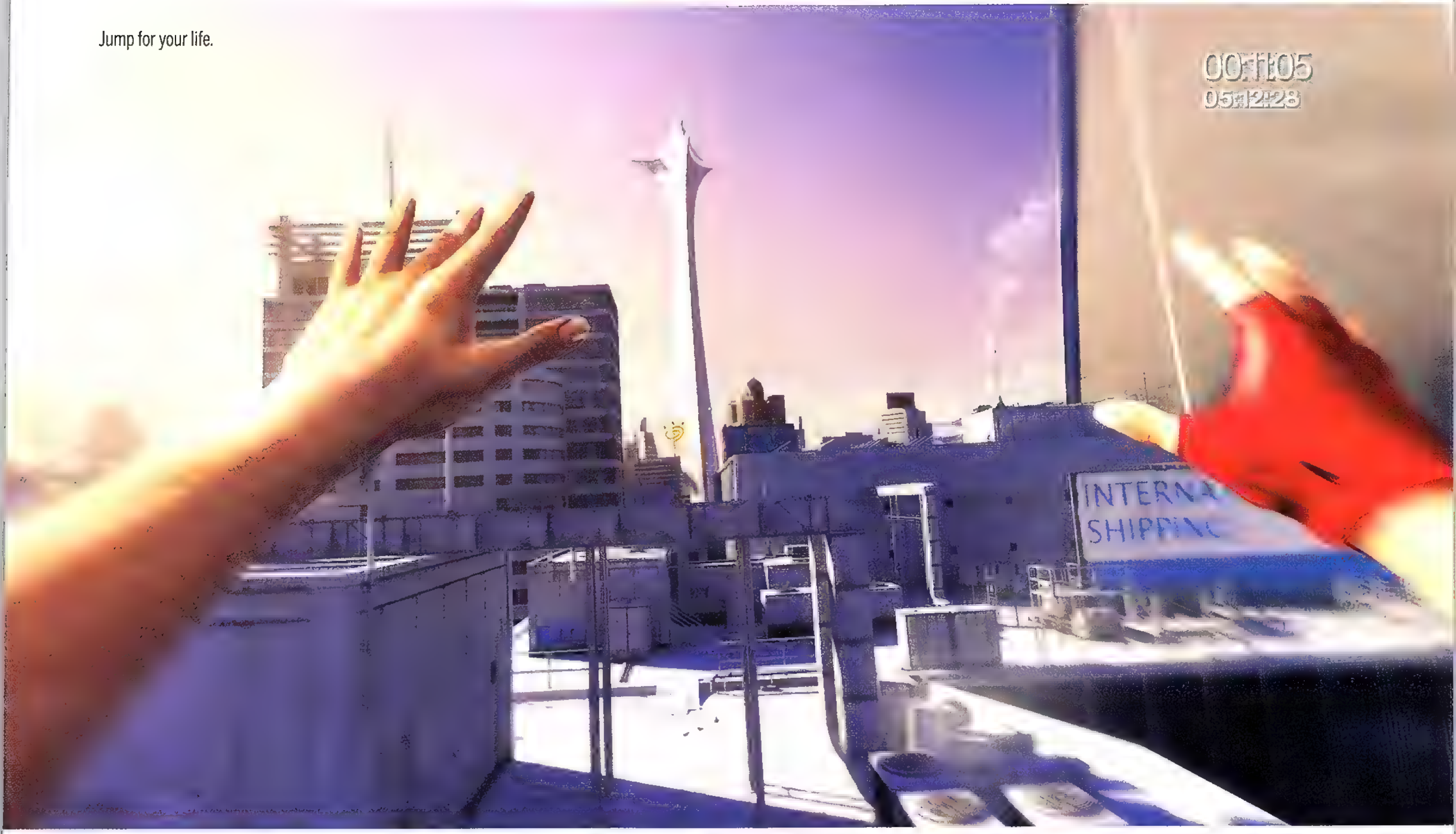
Rushing bosses.

Hexblade is in the same sphere as games like *Titan Souls* and *Furi*, in that the only enemies you'll be battling are bosses. But here they're queued up in the same hallway, emerging one after another, even saving you the trouble of making your way to each boss arena.

Hexblade's bosses are decently complex, and pretty challenging. While lacking multiple boss stages, there are patterns to memorise, projectiles to dodge, and weak points that can be tricky to reach with your sword. Die and you'll return to before the latest boss (thankfully), so it's easy to retry when your luck runs out.

Satisfying as it is, I probably wouldn't be writing about *Hexblade* if it wasn't for the novel Curse bar under the hero's health. This discourages button-mashing by filling up when you swing your blade – and killing you outright when it tops. It's a great idea that made me check my attacking a few times, if not quite to the extent I imagine the developer was hoping for.

A neat innovation in a boss rush videogame that's worthy of your time. **Tom Sykes**
★★★☆☆


Jump for your life.

GAME CHANGER

Mirror's Edge

Taking a leap of Faith with the queen of parkour. By Nat Clayton.

RELEASE 2008 **DEVELOPER** Dice **PUBLISHER** Electronic Arts **LINK** www.ea.com/en-gb/games/mirrors-edge

You don't often think about running in games, do you? Hold W to go forwards, maybe tap shift if you're really hoofing it. Then there's *Mirror's Edge*, a game so committed to putting you in the free-running shoes of leading lady Faith Connors that you can practically feel the soles wearing out with each jump, slide, and wallrun. Parkour might not be as cool now as it was in 2008, but over a decade later, Faith is still running circles around the competition.

Mirror's Edge is a first-person parkour-'em-up from *Battlefield* creator DICE, who briefly put the guns away to make a game where running away was as dense and satisfying as any FPS gunfight. It's a game about running and vaulting and sliding your way across rooftops at blistering speed, even if the occasional naff brawl puts the brakes on things every now and then.

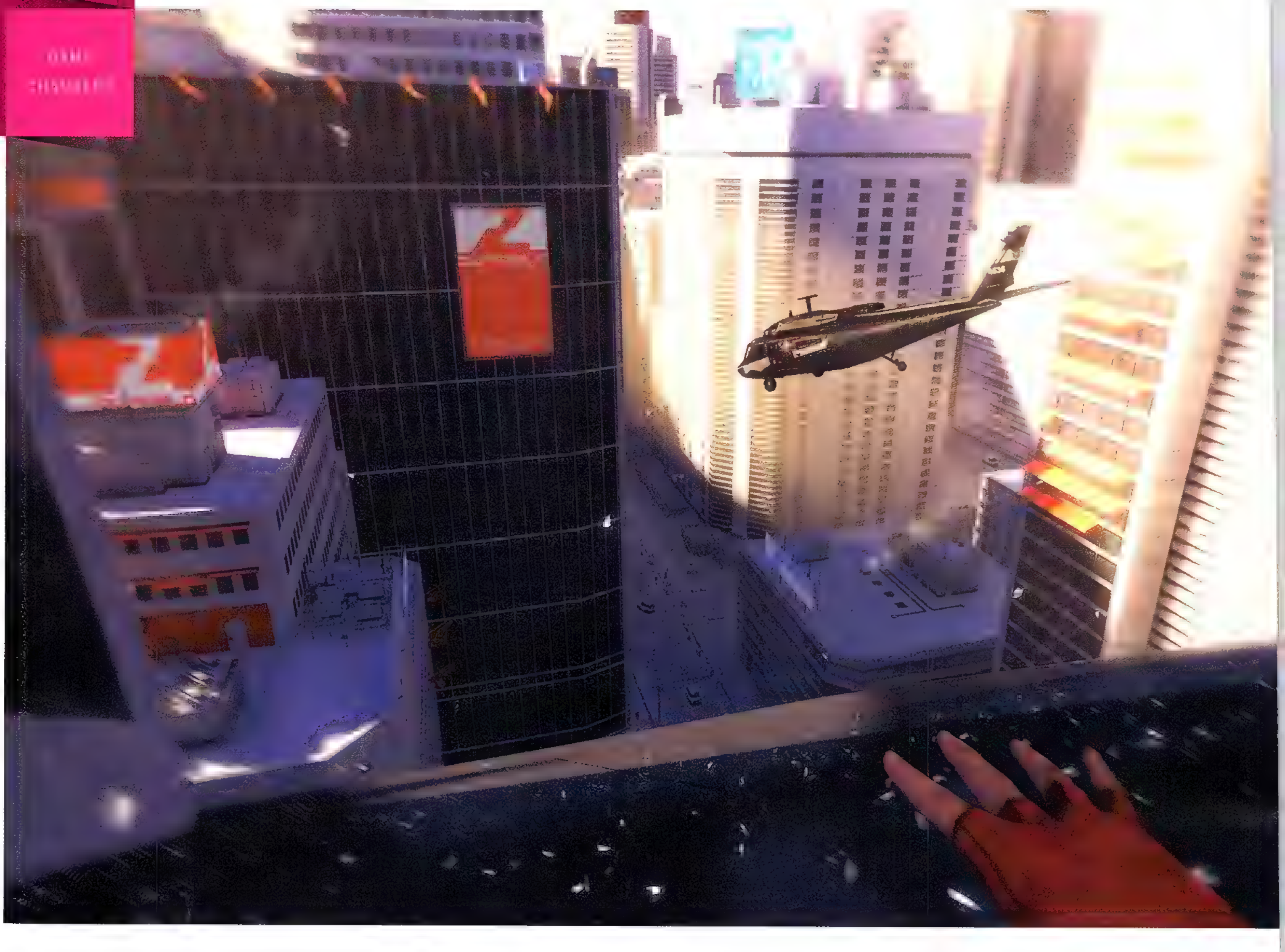
I've always been a sucker for good movement. *Jet Set Radio Future* set the template as far as I'm concerned, its cel-shaded skates kicking off a lifetime's fascination with the ways games tackle traversing a 3D space – be it trying to master *Quake*'s bunnyhops, to conserving speed through a tactical buttslide in *Apex Legends*. Games where you could strip out everything but the character controller and still have fun running and jumping and sliding around.

But *Mirror's Edge* has a physicality to it that hasn't really been matched before or since. You are Faith, in a tangible, meaningful way. Plenty of games show you your characters legs when you look down, but *Mirror's Edge* gives you such a powerful sense of what Faith's body is doing with each move. Her hair even sways with the wind, a needlessly frivolous effect considering you never leave a first-person perspective, and yet grounds you as a physical entity within the world.

You feel each footstep as you kick up to speed, and feel the weight of her body as you bounce off walls and vault over pipes. Where *Titanfall*'s wallruns are fast and effortless, *Mirror's Edge* forces you to feel the gravity of the physics-defying reality of sprinting sideways.

Mastering Faith's movements takes real work, and I found myself stumbling over every step and ledge. But it didn't take long for the muscle memory to kick in. See, back in school, a mate and I used to race each other across the game's rooftops, spending weeks at a time shaving fractions of a second off each other's paces on just the first time trial map.

We were speedrunning, long before I was really conscious of what speedrunning was, and a few levels into this revisit all the old tricks came rushing back. The sidestep jump that pulls you from a standstill to a full-speed sprint. The cheeky wee kick at the end of a



Above: There's no cooler feeling than sliding down a skyscraper.

wallrun to give you a few frames of coyote time. *Mirror's Edge* is crammed with techniques that blur the line between intended play and full-on, boundary-breaking speedrun strats.

Getting good at running also helps you avoid the game's infrequent shootouts, which flatly aren't great. Yes, I adore that your embodiment of Faith means guns do feel awkward in her hand (she's a runner, not a soldier), but *Mirror's Edge* is ultimately not brave enough a game to forgo fighting entirely – and when scraps happen, they're a clumsy mix of awkward first-person brawling and haphazard shooting.

Urban flight

That shooting is joined by the game's story as aspects of the game that feel sorely lacking. *Mirror's Edge*'s plotting feels like an afterthought, a wholly uninspiring conspiracy told through animated cutscenes that feel rushed and disconnected. Your cop sister's been framed for murder, see, and in trying to clear her name Faith gets roped into a tangle of corporate scheming to take over the city's police force. *Mirror's Edge* has a neat set-up with its illegal, free-running Deliveroo gangs, but never really does anything interesting with it.

Here's the thing: I think *Mirror's Edge* is probably the best *Matrix* videogame to date. Think about it. You're sprinting through hallways and rooftops across a sprawling, non-distinct city, fleeing faceless cops at every turn. You have your very own operator guiding you through each job, telling you exactly which alley to turn down and which door to punch through to best evade the law. There's even a wee bit of bullet time, though it mostly operates as a tool to make disarming cops a little easier.

As cool as she is though, it's the city, not Faith, that's the main character of *Mirror's Edge*. Never named, vaguely American but geographically impossible to pin down, the city has such a sterile sense of character. I can't stress enough how good this leaves *Mirror's Edge* looking, a vibrant art direction lending its city a timeless look.

The story might be clumsy, but you don't need characters and dialogue to tell that this is a deeply post-9/11 world of encroaching surveillance and rampant privatisation. A dystopia painted in clean white concrete, broken only by stark, garish signs for energy drinks and private security.

Corporate hellscapes are hardly new for cyberpunk. But *Mirror's*

RUNNING BUDS

Stretch your (digital) legs with these athletic alternatives

TITANFALL 2

The gold standard for game movement. Think *Mirror's Edge* with the limiters turned off, featuring the undisputed king of buttslides.

ASSASSIN'S CREED

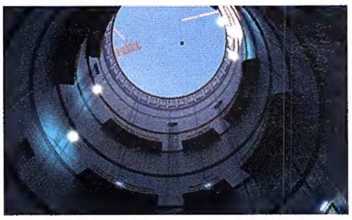
Ubisoft's free-running might be simplistic, but there's joy in bounding entire cities in seconds.

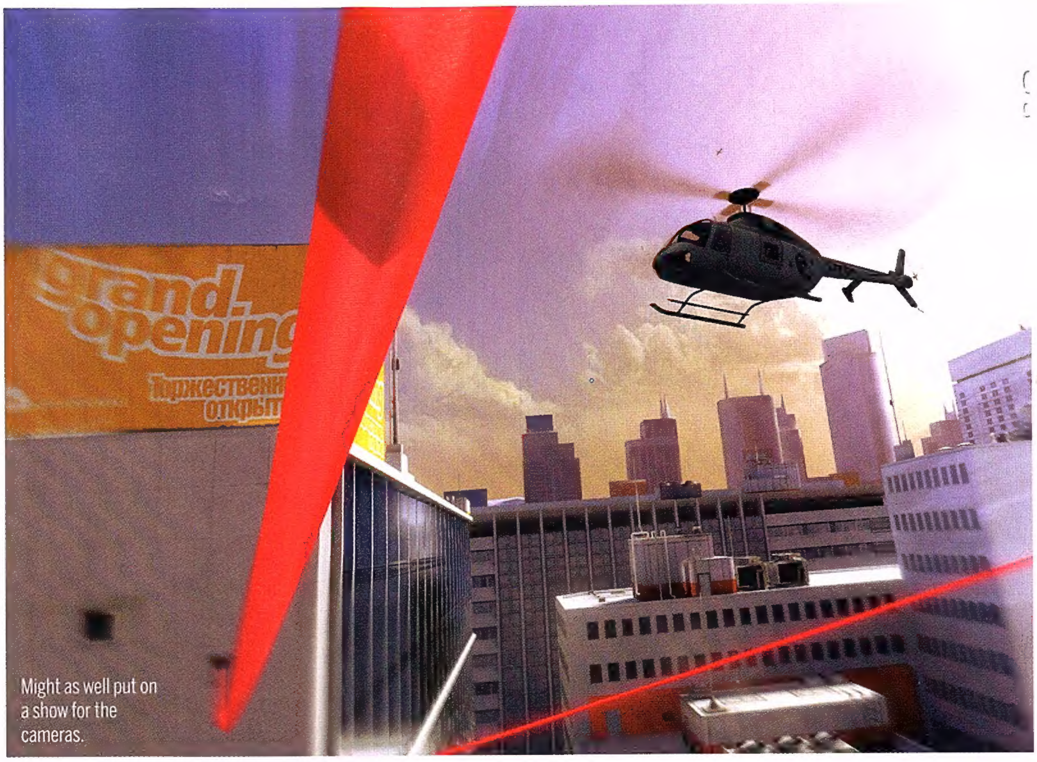
GHOSTRUNNER

Prefer your wallrunning in a more cyberpunk flavour? *Ghostrunner* even gives you a sword so you can slash while you dash.

MIRROR'S EDGE: CATALYST

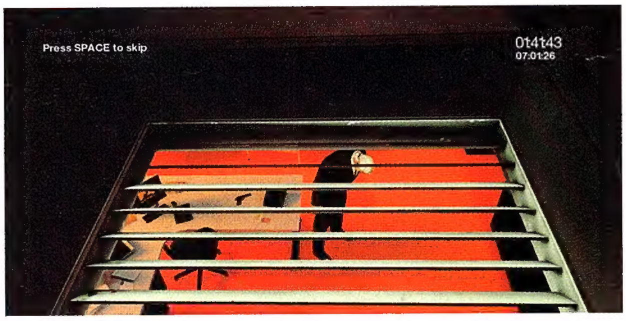
As much as I've bashed it, *Catalyst* is still a strong parkour sandbox – one that plays a little nicer with modern PCs.





Might as well put on a show for the cameras.

Right: What happened to PhysX, anyway?
Far right: Faith joins a time-honoured tradition of lurking in vents.



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Edge never quite crosses that line into being true cyberpunk, modelling its architecture off 20th century high-rises and more contemporary monstrosities. It avoids a trap its own sequel fell into, with *Mirror's Edge: Catalyst's City of Glass* offering a more fantastical metropolis – one that's so sparkling and clean that you never get the sense the city was anything other than brand new.

As you descend through concrete canals and back alleys, *Mirror's Edge*'s city gives you a strong sense that there used to be something here. At least, before the city council stumbled upon a warehouse full of white paint.

Redline

That starkness serves a purpose too. One of *Mirror's Edge*'s smarter ideas was 'runner vision' – and while the name implies a *Witcher* or *Arkham*-esque mechanic that desaturates the screen, highlights interactive objects and maybe slows down time, Dice chose a more subtle approach.

Instead, runner vision applies a sharp red tint to your path through a level, screaming against the desaturated whites and greys of the rest of the map. Which door to open, which pole to climb, while box to spring-jump off. It allows the game's levels to be dense without leaving the player utterly lost. Can't work out where to go? Just follow the red.

Runner vision can be turned off, of course, but it's important to note that while runner vision will guide you down the most direct path, it's often not the fastest. It's always worth keeping an eye out for riskier routes that might shave seconds off your time. A long pole climb might be averted by wall-bouncing off an exterior vent onto a series of AC units, and only a chump would use the stairs when there's a perfectly precarious fence to hop.

Mirror's Edge's neighbourhoods are dense with this kind of detail, with time trials reworking even the smallest blocks into complex parkour playgrounds. It might take seconds to sprint across a few rooftops to the RP&A building in the game's first chapter, but you'll spend hours trying to complete a loop around just one of those building's billboards.

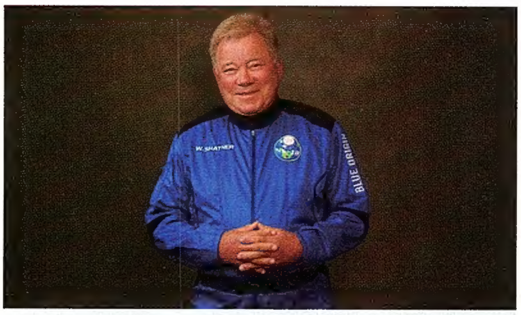
It works because, fundamentally, *Mirror's Edge* is still linear. The idea of an open city where you could free-run anywhere is still tempting, even now, but it's this guiding that keeps Faith's movements feeling fast and tight. Every jump, every wall, every fence has to be carefully considered. Every level gets to find its own route without trying to fit within a greater urban structure.

Catalyst made *Mirror's Edge* busier. Not only with an open world, but with progression trees, fussier combat, a wider cast of characters and more stakes. But *Mirror's Edge* never needed any of that fuss.

It's a game about running, pure and simple. About hearing the wind rush past your ears as you pound ground, carving a route though a concrete jungle. It's expression through movement, an encapsulation of what traversal in 3D space can mean. This runner might be old, but they're still the best in the game. ■

CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS



WILLIAM SHATNER RIDES BEZOS' BLUE ORIGIN ROCKET INTO THE STRATOSPHERE

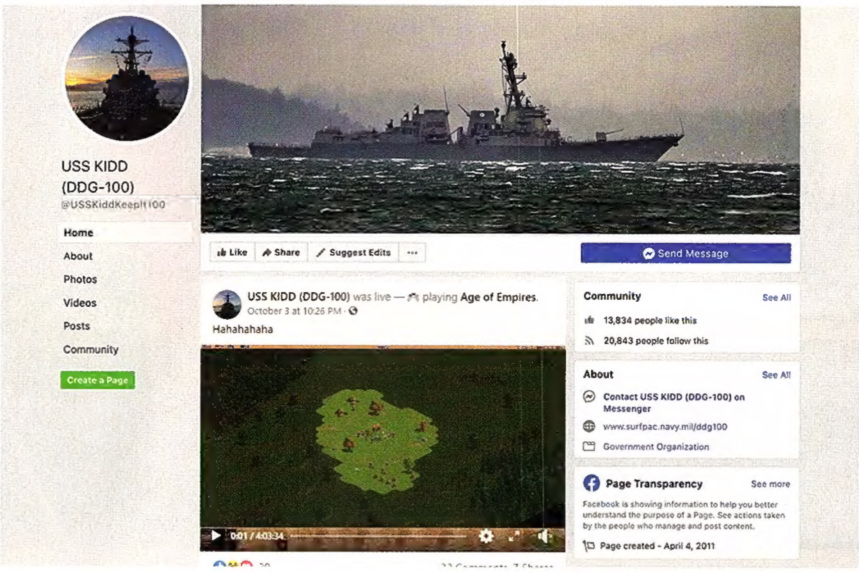
Did we pay for all this too, Jeff?

Star Trek's Captain James Tiberius Kirk, a.k.a, William Shatner, took his first flight into actual space on October 14th, becoming the oldest human to leave the Earth's atmosphere at the age of 90. While the actor was the commander of the USS Enterprise for four decades, he described his 11 minute ride into the void as "the most profound experience". Clearly grateful for the experience, Shatner thanked his benefactor by bringing a bit of shade back from the edge of the universe and throwing it on all those other Silicon Valley space dudes for the cameras: "whatever those other guys are doing... I don't know about them".

FACEBOOK WANTS BETTER PRESS BY SUPPRESSING NEGATIVE STORIES

We wish we were joking.

We normally would have covered this story on our *Random Access* page, so we understand the irony of critiquing self promotion in a piece relegated to a smaller segment of the mag, in order to make way for an article about how amazing *APC* issue 500 is. It is very different, however, to officially sign off on a concerted effort to manipulate a supposedly independent news feed to ensure people are only able to see positive news stories about your company, which is the aim of Facebook's 'Project Amplify'. This is exactly what CEO Mark Zuckerberg did, by agreeing to proceed with Project Amplify in a quest to be seen in a better light in stories on its own site.



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USS KIDD (DDG-100) was live — playing Age of Empires.
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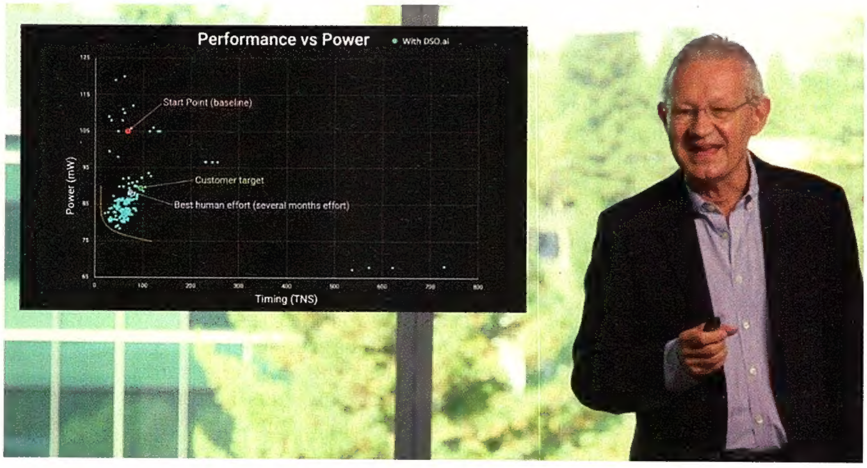
Navy Facebook hacked for *Age of Empires* livestream

Hackers sunk my battleship.

In October, the 1,900-strong Facebook following of the US Navy destroyer USS Kidd would have been surprised to see that the page was being used to livestream the classic strategy computer game *Age of Empires*. The initial livestream was preceded by posts like "Hahahaha" and a little later, perhaps when they realised the gravity of the situation, "fffffffff", so we can only assume that the aptly named warship's page had been overrun by kids. The 'hackers' managed to hold onto the page for the better part of a working week and pumped out six live streams before Facebook revoked access and returned it to the defence force.



SAMSUNG IS LETTING THE COMPUTERS DESIGN THEMSELVES

Can the black box build better black boxes?

The South Korean silicon maker is one of the first to begin leveraging AI smarts in the complicated art of processor design. The company intends to use Synopsis' tool DSO.ai to expedite the chipmaking process and, hopefully, discover new more efficient chip designs. Synopsys has used its large catalogue of designs to train the machine learning tool to create cutting edge processors, and Samsung is using it to create its next Exynos smartphone processors, according to a report by *Ars Technica*. Google apparently used AI to configure the arrangements for its data centre Tensor chips already, but it wouldn't comment if machine learning was used in its Pixel 6 AI processors. ■

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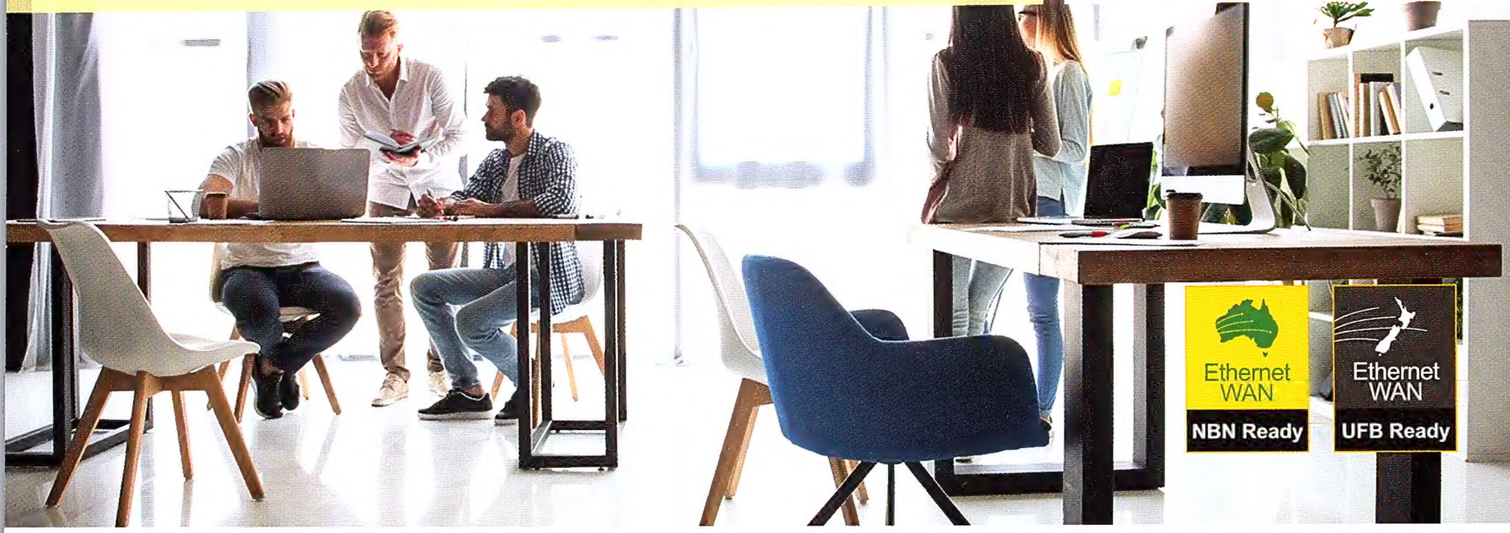

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